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LANDSCAPE ARCHAEOGEOPHYSICS: A STUDY OF MAGNETOMETER SURVEYS FROM ETOWAH (9BW1), THE GEORGE C. DAVIS SITE (41CE19), AND THE HILL FARM SITE (41BW169)

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by

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The University of Texas at Austin, 2009

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Archaeogeophysics, the use of eophysical mapping techniques to recover archaeological information, is being used with increasing success in North America. Archaeologists can often use geophysics as a tool for collecting data suitable for direct archaeological interpretation (Kvamme 2003). In some cases, geophysics can be used to map entire archaeological landscapes providing an image of the site that is not easily achievable through the use of traditional archaeological excavations. This dissertation uses archaeogeophysical data from three prehistoric sites to gain insights into their layout and community organization as well as explore the possibilities and potentials of using broad scale geophysical surveys in North American archaeological research.

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CHAPTER 1, INTRODUCTION

Geophysics has changed the way archaeological investigations in North America are conducted. Methods and techniques that were once all but ignored by North American archaeologists have now come to the forefront of the discipline and have been repeatedly used on archaeological sites across the country over the last 20 years (Bevan 1998; Conyers 2004; Dalan 1987; Ernenwein 2008; Frederick and Abbot 1992; Hargrave et al 2007; Lipo et al. 2004; Lockhart 2007; Kvamme 2008; Perttula et al 2008; Prentiss et al 2008; Toom and Kvamme 2002; Kvamme and Ahler 2007; Walker and Perttula 2008; Weymouth and Nickel 1977). The time has come to put to rest the question as to whether geophysics can play a productive role in the American archaeological discipline and to start drafting a broader approach to archaeological research that incorporates geophysical techniques into its very fabric.

This dissertation address the following fundamental questions:

- To what extent can archaeogeophysical data be utilized as a primary source of archaeological data? and,
- How can archaeogeophysics be more intrinsically integrated into the larger pursuit of North American archaeological research?

Kvamme (2003) has convincingly argued that archaeogeophysics can be used to produce primary information regarding a site's content, structure, and internal spatial organization. Kvamme notes that geophysical surveys can include the investigation of large portions of a prehistoric landscape in as efficient and extensive way that, due to funding and time constraints are often times impossible to examine through traditional archaeological methods. In this dissertation, I employ three geophysical data sets from Georgia and Northeast Texas that are well suited, for varying reasons, to landscape studies and all contain geophysical features in the data that are quite familiar to archaeologists who specialize in the archaeology of these North American regions. All three cases illustrate Kvamme's argument that archaeogeophysics can be used as the primary source of information for the archaeological investigation of prehistoric landscapes.

All three of the magnetometer data sets discussed here provide significant leaps forward in our understanding of the community organization and site layout to their respective sites. I will argue that the use of large area magnetometer surveys provides a much more useful tool than locating archaeological objects on the ground, but provides us with hints as to the nature of how these prehistoric communities were organized and arranged. We see not only the archaeological remains of structures and pits, but also can define plazas and public spaces.

This study includes archaeogeophysical datasets obtained from the Etowah site in northwestern Georgia, and the George C. Davis and Hill Farm sites, both located in Northeast Texas. These three sites have different cultural and temporal affiliations. Etowah is a Mississippian site that dates from A.D. 1000–1625 (King 2003:29). The George C. Davis site is an Early Caddo period mound center and village that dates from ca. A.D. 850-1300 (Story 2000) and the Hill Farm site is a Late Caddo period site that was occupied from ca. A.D. 1500 (Perttula et al. 2008).

The primary thread that ties these three projects together, besides the fact that the author worked as a graduate student at the Davis site during the course of the geophysical surveys there (see Creel et al. 2005), and directed the geophysical surveys at both Etowah and the Hill Farm site, is that all three sites have produced archaeogeophysical data that can be used with great clarity as a primary source of archeological data. The archaeogeophysical projects that have been conducted at these three sites are all part of a larger trend in archaeogeophysics towards collecting geophysical data at the scale of the prehistoric landscape. With Etowah and the George C. Davis site, this has been accomplished through both the sheer size of the dataset as well as their archaeogeophysical clarity. At the Hill Farm site, a landscape perspective is achieved through the use of the 1691 Teran map of the Caddo community that the Hill Farm site was part of, and that was visited by a Spanish entrada.

Chapter 2 provides an overview of the field of archaeogeophysics, focusing on archaeogeophysical research that has been focused on landscape-scale studies. I also discuss the various instruments that are often used in archaeogeophysics as well as the field methods and data processing procedures that are employed in the gathering and analysis of geophysical data. This chapter also includes overviews of several of the foundational archaeogeophysical studies that have been conducted across the United States.

Chapters 3-5 present the results of archaeogeophysical surveys at the Etowah, George C. Davis, and Hill Farm sites. Each chapter presents an overview of the previous archaeogeophysical research that has been conducted at each site, followed by a discussion of the specific field methods and data processing procedures used in each geophysical survey. For each site the archaeogeophysical results are presented within a site-specific context, including a discussion of the site-specific criteria employed in the interpretation of the geophysical data. The datasets are broken down into three major groups: (1) modern (non-archaeological) cultural anomalies, (2) geological anomalies, and (3) prehistoric archaeological anomalies. A site-specific typology of archaeological structures is also discussed in each chapter, along with, when possible, the larger intra-site spatial patterning of archaeological anomalies, including structures, mounds, and other features.

In Chapter 6, the archaeogeophysical data and interpretations presented in Chapters 3-5 are synthesized and used to illustrate the types of archaeological questions that can be addressed through the broad scale use of archaeogeophysics. The chapter concludes with a consideration of the future direction of the use of geophysics in landscape archaeological research.

CHAPTER 2, THE USE OF ARCHAEOGEOPHYSICS IN ARCHAEOLOGY

Introduction

In this chapter I discuss the general use of geophysics in archaeology and the growing specialization of its use in Landscape Archaeology. I then turn to a description of the instruments currently used in archaeogeophysical research, as well as their collection methods, data processing procedures, and data analysis techniques.

Geophysical prospecting has recently become much more of a particular focus in the pursuit of American archaeology (Kvamme 2003), despite its relatively long history of use in Great Britain in archaeological studies, where geophysical prospecting techniques have been used with varying success since the early 1950s (Clark 2000:11). Several techniques have been borrowed from geophysical prospecting and adopted for archaeological investigations, and these have recently been used for large scale archaeogeophysical projects that are examining entire ancient landscapes (Gaffney et al 2008; Gaffney and Gater 2003; Clark 2000). The techniques used primarily for archaeogeophysical research include magnetometer, soil resistivity, soil conductivity, magnetic susceptibility, and ground penetrating radar (Gaffney and Gater 2003; Gaffney 2008). For general summaries of archaeo-geophysics, the reader is referred to Aspinall et al 2008, Clark (1990), Gaffney (2008), Gaffney and Gater (2003), Bevan (1998), Piro (2009), Scollar et al. (1990), Weymouth (1986), Witten (2006), Conyers (2004), and Conyers and Goodman (1997).

Archaeogeophysics

The term archaeogeophysics used throughout this study follows Kvamme's (2003:435) definition that it consists of "methods of ground-based remote sensing that allow the detection, imaging, and mapping of subsurface features over large areas in potentially great detail." Often confusing matters, there are several different names that have been given to this practice. In Europe the term "archaeological prospection" persists, and is also the name of the field's flagship journal, *Archaeological Prospection,* published by John Wiley & Sons, Ltd. In North America the term "remote sensing" is often used, which is technically true, but quite general in its meaning.

The term "archaeological prospection" implies that archaeological sites are in fact being prospected for or discovered through the use of geophysical survey, which is not always the case. Archaeogeophysics, or Archaeological Prospection, with few exceptions (Powlesland 2009) is conducted in areas that have already been defined as a "site" and are used to further our understanding of that site, not to discover them. Discovering sites is, however, a continuing goal of archaeogeophysical research (Campana 2009:20), just not one that has widely been put in practice. The term "remote sensing" often used in the literature in the United States (Johnson 2007; Perttula et al. 2008; Bruseth et al. 2007) is a legitimate one to use, but it can also be misleading due to the large numbers of other instruments and techniques that also are subsumed under the rubric of this term, such as multi-spectral satellite imagery and areal photography.

Admittedly the term archaeogeophysics does not evoke a strong sense of excitement in the archaeological discipline, and can even be a technical barrier that intimidates non-specialists from delving into its literature for fear that what they will find will more closely resemble physics and geophysics than archaeology. This is true: archaeogeophysics is a technical field involving many mathematical and theoretical concepts borrowed from physics. The term, archaeogeophysics, is not meant to deter the archaeologist, but it is used here because it more clearly and accurately conveys the reality of the discipline. Archaeogeophysics is a technical field that has its feet firmly planted in the field of archaeology with its ultimate goal being to broaden our understanding of the archaeological past, but it uses geophysics as sources of data, and as such is both constrained and empowered by geophysical principles.

The development of the field of archaeogeophysics primarily took place in England (Clark 1990:11-26). Scientists seeking for a way to locate objects with extremely large magnetic fields, such as kilns, started researching the use of instruments to monitor and record these magnetic fields. Through trial and error these early techniques, which also included the use of resistivity meters, grew into a fully-fledged discipline by the early 1970s. Clark (1990:11-26) and Gaffney and Gater (2003:12-24) provide the most complete account of the historical development of archaeogeophysics.

In recent years archaeogeophysics has continued to be used with increasing frequency throughout Europe, Asia, Africa, and the Americas (Piro 2009). There is a general trend noted in archaeogeophysical research to the collecting of larger and larger areas of archaeological space (Aspinall et al. 2008:179-188; Campana 2009; Becker 2009; Dabas 2009; Gaffney 2008; Gaffney and Gater 2003:180-183; Powlesland 2009). This trend is largely due to technical advances in the field of geophysics as instruments are being designed with multiple sensors and data collection rates are correspondingly being increased (Leckebusch 2005; Gaffney et al. 2008). Developments in the instrumentation used in land surveying, such as Real Time Kinematic (RTK) GPS and robotic total data stations, allow for quick and precise measurements that can be used to “position” the readings taken from the various geophysical instruments. These technological advances have allowed for the development of a new methodology in the field of archaeogeophysics that constitutes a quantitative shift in the spatial scale of its research area. It is now possible to survey entire archaeological landscapes in order to obtain a “big picture” perspective of archaeological landscapes that has before never been possible. This new methodology, referred to here as “Landscape Archeogeophysics,” is still taking form as archaeogeophysical researchers experiment with its technical aspects and continue to re-frame the nature of the archaeological questions than can be addressed through its use.

Archaeological Landscapes

Landscapes and more specifically archaeological landscapes are terms that are used with such frequency in the archaeological discipline that their specific meanings tend to have been obscured in archaeological practice. I use the term in its most broad sense, traced back to Aston and Rowley (1974), as a scale of inquiry that is greater than the “site.” The term is also used in a conceptual framework “that enables us to address human pasts in all their contexts and that goes beyond a purely environmental archaeology” (David and Thomas 2008:38). And finally in many ways regarding archaeogeophysics, the study of archaeological landscapes is meant to suggest a new set of possibilities for research and an unconstrained scope of data collection made possible through the continued development and integration of mapping technologies in archaeogeophysical research.

Landscape Archaeogeophysics

European scholars are leading the way with landscape scale archaeogeophysical surveys. More surveys have been completed at sites in Europe, Africa, and Asia that have exceeded 1 km^2 (100 hectares or ha) than those that have exceed a mere 20 ha on North American sites. The tradition in Europe of using geophysics for broad scale archaeological surveying cannot simply be explained by the recent advances in technology but is also a reflection of the general differences in the North American and European archaeological disciplines [REF?].

Until the advent of GPS-guided collection (Leckebusch 2005; Gaffney et al. 2008), archaeo-geophysics has typically been conducted in small controlled areas or “Data Grids” (or DG). For many of the same reasons that traditional archaeological investigations are performed in small controlled units (i.e., limited amounts of time and money and the need to more closely manage the dataset), archaeo-geophysics projects have also focused on individual collection units or DG. While there is no set size for this unit of study, there is a tradition of using 20 x 20 m DG. This size is chosen (along with 10 x 10 and 30 x 30 m DG) in part due to historical precedent and partly due to the physical limitations of many instruments used in archaeo-geophysics: most notably the GeoScan Research

RM15 Resistivity Meter and the FM36 and FM256 Fluxgate Gradiometer. These two instruments, and GeoScan Research's 2D signal filtering software package GeoPlot, have been the undisputed workhorses of archaeogeophysics, so much that more advanced modern instruments and software packages have copied GeoScan Research's basic data collection parameters by sticking with the same DG size options (Bartington and Chapman 2004).

Landscape scale archaeo-geophysics has no doubt been, and will continue to be, connected to advances in survey speed and accuracy, but the first few projects that were conducted at the landscape scale did so using traditional archaeo-geophysical methodologies. Two British archaeo-geophysical projects, "The Heslerton Parish project" and the "Wroxeter Hinterland project", pushed the discipline to cover larger and larger areas for archaeological reasons. These two projects, however, demonstrate the power and potential of archaeo-geophysics at the same time that they serve as a warning of the pitfalls and difficulties of working at the landscape scale; they have been described by a principal investigator of the Heslerton Parish project as a nightmare and a dream (Powlesland 2009:180).

Starting in the late 1970s archaeologists working along the western side of the Vale of Pickering began to amass an archaeo-geophysical dataset that is beyond the scale of anything that had ever been attempted. The Heslerton Parish project, which is managed by the Landscape Research Center with support from English Heritage, has collected over 12 km^2 (1200 ha) along the western side of the Vale of Pickering (Powlesland 2009:177). The Heslerton Parish project and its data along the Vale of Pickering not only constitute the largest archaeo-geophysical data set in the world, it also has obtained the largest and most detailed information on archaeological landscapes in Britain (Powlesland 2009:178).

Figure 2.1. Interpretative map of the gradiometer survey of the Valle of Pickering. Color scale shows the depth of Aeolian sand deposits. Black lines illustrate the archaeological features recovered by the survey. After Powlesland et al 2006:298.

The Wroxeter Hinterland project was a long term collaborative research project that has studied the economic and social changes brought on by "Romanization" in Britain (Buteux et al. 2000:69). Part of the Wroxeter project was a large scale, multi-instrument, archaeo-geophyiscal survey. Researchers from GSP Prospection and the AM Lab, English Heritage, collected more than 70 ha of magnetometer data at Wroxeter that covered the entire ancient cityscape (Gaffney et al. 2000; Gaffney and Gater 2003:150-155). This magnetometer dataset provides a complete city plan of a Romano-British *civitas* capital and provides insights into the city's social, economic, and functional zones (Gaffney et al. 2000:98).

Figure 2.2. Grey-Scale plot showing the results of a gradiometer survey of the Roman city of Wroxeter. After Gaffney et al 2000:84.

The Bavarian State Conversation Office in Munich, Germany, has been involved in many collaborative landscape archaeo-geophysical projects, several of which have exceeded 100 ha in size (Becker 2009). Between 1996 and 2004 over 200 ha were surveyed using several different cesium sensor arrays at the site of Qantir-Piramesse, the city of Ramesses, in Egypt's Nile Delta (Becker 2009:129). From 2003-2006, more than 100 ha were surveyed at the Celone Valley project in the Tavoliere in Apulia (Becker 2009:129). Over 50 ha were surveyed at the Roman fort and necropolis near Ruffenhofen in the Middle Franconia, revealing the site's defensive walls, towers, and buildings (Becker 2009:142).

At the Roman city of Miletus, now refered to as Miletos, located in western Turkey, a recent large scale multi-sensor archaeo-geophysical survey has been completed by Rabbel et al. (2004). Most of the 200 ha site has been surveyed using a RTK GPS (< 1 cm accuracy)-guided cart-mounted fluxgate gradiometer towed by a tractor. This work has revealed important and heretofore unobtainable archaeological information on the delineation of the ancient urban, agricultural, and shore line areas, and has located and helped reconstruct the ancient harbor basins, building plans, and the city's water and canal system (Rabble et al. 2004:691). The use of GPS-guided magnetometers, such as employed at Miletos, is one of the more promising directions for the future of landscape archaeo-geophysics (see Chapter 6).

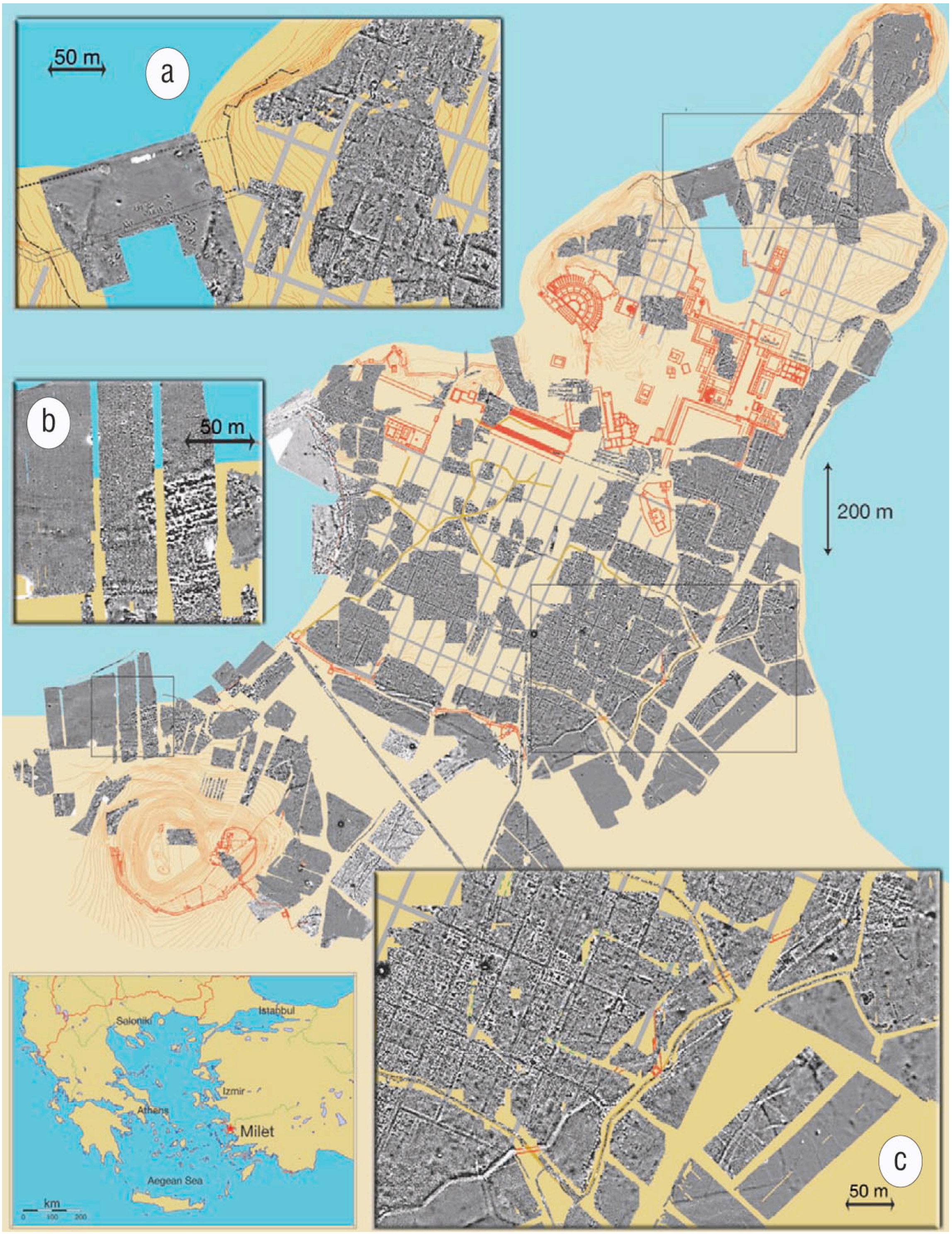

Figure 2.3 Greyscale plot of the gradiometer survey at Miletus, (a) shows the Lions harbor and Hippodamian street system, (b) shows the Roman basilica nea the ancient shore, (c) shows Hellenistic city wall. After Rabbel et al 2004:690.

Another recent application of the new Foerster Ferrex GPS-guided fluxgate gradiometer was the collection of archaeo-geophysical data at the site of Cyrene in Libya (Gaffney et al. 2008). Gaffney et al. (2008:155) found that using this GPS system not only allowed them to collect large areas with increased efficiency, due to decreased setup times and quicker traverse tempos, but the RTK GPS precision actually produces a dataset that is more accurate than data collected using the traditional gridded technique. This is a method that increases the archaeological view by adding a more complete landscape perspective to the archaeo-geophysical research effort, as well as maintaining the precision of the surveys for the sake of future feature exploration.

LANDSCAPE ARCHAEO-GEOPHYSICS AND MAGNETOMETERS

Several of the landscape studies discussed above as well as those included in the chapters that follow have heavily on the use of magnetometers. This is due to their survey speed, their ease of use, and the high success rate of the magnetometer in detecting archaeological features and anomalies. Consequently, magnetometers are now and for the foreseeable future the dominant geophysical tool used at the landscape level (Aspinall 2008:179-188). This is not to suggest that the additional geophysical techniques, such as those described below, are not useful (e.g, Conyers 1995, 2004:145-177; Kvamme 2008), but that with their current design constraints other geophysical methods are not as useful for the kinds of broad area coverage that has been completed at Wroxeter and the Vale of Pickering, and that are needed to be conducted on North American sites/landscapes.

Geophysical Techniques used in Archaeology

Archaeo-geophysics employs a range of techniques for the non-destructive prospecting of archaeological deposits. These techniques have been developed for a range of applications, mostly geological in nature, but they have been adapted for specific use in archaeological research through rigorous field collection techniques and unique data processing programs specifically developed for the study of the archaeo-geophysical record.

In general, all geophysical techniques map, record, or sense different variables or properties of the soil and the objects contained within the soil. The geophysical instruments are differentially affected by variables such as moisture, metal trash or debris, and transmission of signals such as cell phones and transmission lines. Data collection is also impacted differently for each of the geophysical instruments by physical impediments such as trees, pavement, fences, and vegetation.

Archaeologists have found that the best strategy for dealing with this complex matrix of variables is to come to the field prepared to collect data with several different instruments. The "multiple-technique" approach not only increases the likelihood of success in the ability to detect archaeological features of interest, but can often enhance the visibility of the archaeological targets that may be present and preserved at archaeological sites (Kvamme et al. 2006:251; Kvamme 2006a:57-58).

MAGNETOMETER

Magnetometer and gradiometer surveys are non-invasive and passive techniques and measure slight variations in the magnetic properties of soil.

Magnetometers have become the primary tool for archaeo-geophysicists working on archaeological sites, in part due to the fact that data can be collected and processed rapidly and efficiently, and when conditions are right due to the properties of specific soils, magnetometers have proven useful in locating negative relief features such as pits and post holes as well as thermally-altered features such as fire hearths and burned structures (Aspinall et al 2008:143-178).

Magnetometers record the minute fluctuations that sediments and objects have on the earth's magnetic field. This is known as induced magnetism because the object does not maintain its own magnetic field. If the effects of this induced magnetism are strong enough compared to the surrounding soil matrix, pit features or post holes can be identified or resolved in the geophysical data. A second type of magnetism called remnant magnetism is created when an object maintains its own magnetic field. In prehistoric archaeological examples, this occurs when objects are thermally altered, thus creating a magnetic state called thermoremanent magnetism (Kvamme 2006b:207).

A classic recent example of archaeogeophysical survey using a magnetometer is Kvamme's (2008:62-79) survey of the Double Ditch Historic Site in North Dakota. The Double Ditch site is a historic Mandan village that was visited by the Lewis and Clark expedition in 1804 (Kvamme 2008:62-63). An 8 ha magnetometer survey at the site was successful in locating several dome-shaped earth lodge houses as well as a ditch and palisade system.

Electrical Resistance

This technique has proven to be one of the most successfully and widely employed methods used by archaeogeophysicists (Bevan 1998:7; Somers 2006:109-110). Resistance surveys measure the resistance to the flow of electric currents through the ground (Gaffney and Gater 2003:26). Resistance surveys can record differences in soil compaction, moisture content, and locations of highly resistant features such as stone (as in stone walls or foundations). Depending on local site and soil conditions, in North American prehistoric archaeological sites, most features recorded with resistance will be negative resistance features, meaning that they fall below the background resistivity of the site (Somers 2006:112). This is due to the fact that most prehistoric features in North American archaeological sites will take the form of some sort of negative relief feature composed mainly of, at varying degrees, soil disturbance.

Resistivity surveys are controlled by constant variables including electric current, voltage, and the geometry of the resistivity probe array. The most common probe configuration is known as the Twin Probe Array, and it was developed specifically for archaeological purposes (Gaffney and Gater 2003:27-34; Somers 2006:112-115). This array uses a set of mobile probes, one injecting the current and one recording the reading (which is an average of the resistance in the area between the two probes), usually spaced with a 0.5 m separation. Probe spacing can be changed to resolve geophysical data to different depths. The 0.5 m separation has proven to be the most useful in electrical resistance for shallow (upper 50 cm) archaeological deposits (Gaffney and Gater 2003:60), as at the Kitchen Branch site (41CP220), a 16th century Caddo site (Perttula 2007). A set of probes are placed off the collection grid at a distance 30 times the mobile probe separation from any point on the grid (i.e., 15 m off the grid when using a 0.5 m separation). An excellent example of resistance data collected by Archaeo-Physics, LLC, is from Mission San Marcos along the Georgia coast

(Somers 2006:126 and Figure 6.11). The resistance data from the mission clearly shows the outlines of a building's shell and lime foundation as well as a considerable amount of the internal construction details of the building.

GROUND PENETRATING RADAR (GPR)

GPR is an active, non-invasive, technique that uses a shielded surface antenna to transmit pulses of radar energy, generally high-frequency electromagnetic (EM) waves, that reflect off buried objects, features, or geological bedding contacts and are detected using a receiving antenna (Conyers 2004:23-28). The waves detected by the receiving antenna are recorded in nano seconds (ns) that reflect the two-way travel time of the radar energy. Fairly accurate approximations of the depth of recorded anomalies can be determined through velocity analysis (Conyers and Lucius 1996).

While GPR is one of the more widely used techniques in archaeo-geophysics, its success, like that of the other archaeo-geophysics techniques discussed in this chapter, is largely based on such site conditions as soil type, sediment mineralogy, and moisture content (Conyers 2004; Kvamme 2003). For example, ideal soil types for profitable GPR investigations include dry homogenous soils with a minimal clay content. On the other extreme, radar energy will become attenuated more quickly in more conductive mediums such as clay deposits, in poorly drained soils, or in sediment mediums with high magnetic permeability (Conyers 2004).

GPR has also proven to be a useful tool for recreating the character of prehistoric landscapes preserved in the archaeological record. Conyers (1995, 2004:145-177) has convincingly demonstrated GPR's ability to map living surfaces as well as architectural remains buried under 2 to 6 m of volcanic deposits at the Ceren site in El Salvador. At the time this was one of the most successful applications of GPR techniques in archaeological research and is still one of the best examples of the utility in using geophysical investigations to reconstruct prehistoric landscapes.

GPR has also been quite useful for locating complex archaeological features such as pit houses. Ernenwein's (2008) recent work at Pueblo Escondido, a Jornada Mogollon site in southeastern New Mexico, used a suite of geophysical instruments to map the prehistoric landscape at this spatially extensive and structurally complex site. Her results demonstrate the differences that various geophysical techniques provided in unraveling the spatial organization of this habitation site in this desert environment. Results from the GPR survey were the most legible geophysical data of the survey effort and clearly showed details regarding the shape, size, and arrangements of individual pit house structures (Ernwwein 2008:129 and Figures 2 and 3).

It is GPR's ability to collect detailed information regarding the depth of its signal (through the use of velocity analysis), combined with its ability to penetrate many foreign objects, that places it in a class of its own when compared to the other instruments used in archaeo-geophysics. This allows for surveys to be conducted in areas where the surface of the soil is not exposed, thus providing the unique ability to map archaeological deposits that are below floors of standing structures as well as those buried under parking lots or concrete. This has recently been demonstrated at the La Villa Rivera/Marian Hall Complex archaeological project in downtown Santa Fe, New Mexico, where GPR surveys have recorded several significant historic structures and archaeological features that are currently below an asphalt parking lot (Conyers 2006; Walker 2008).

CONDUCTIVITY

Conductivity surveys measure the ability to conduct an electric current (Clay 2006:79). This measurement is the theoretical inverse to resistivity (discussed below); however, measuring conductivity entails a much more complex set of procedures than does resistivity (Bevan 1983:51; Clay 2006:79). Conductivity instruments differ greatly from resistivity instruments in that no probes are inserted into the earth. The conductivity has a set of wire coils, one transmitting a low frequency signal and one receiving the signal. The conductivity meter is simply carried above the earth surface and data are logged automatically, making conductivity surveys time and labor efficient (although not as efficient as the magnetometer for geophysical surveys).

Conductivity meters can resolve data at different depths by changing the separation of the transmission and receiving coil and by transmitting its signal at different frequencies. Some instruments allow for these variables to be changed and others, like the Geonics EM38—the most widespread conductivity meter used in American archaeology—are not adjustable.

Conductivity has proven to be a useful tool at different scales in landscape archaeology. Berle Clay's work at the Hollywood site in Northern Mississippi (2006:103 Figure 5.14) demonstrates conductivity's ability to obtain detailed information about prehistoric Native American architecture by producing results that appear similar to those produced by magnetometer surveys. Grealy and Conyers have demonstrated a much more broad scale use for conductivity by mapping large tracts of land for geomorphological features (i.e., old channels, buried point bar and levee deposits, etc.) and revealing relict meander scars of the Red River in northeastern Texas (Grealy and Conyers 2008; Conyers et al. 2008:87-90).

MAGNETIC SUSCEPTIBILITY

Magnetic susceptibility is a measurement of a material's ability to be magnetized (Dalan 2006:161). Changes or contrasts in the magnetic susceptibility of sediments are the results of a conversion of weakly magnetic oxides and hydroxides to more strongly magnetic forms (Dalan 2006:162). Burning episodes (both natural and human-caused) as well as organic and inorganic pedogenic processes can cause the magnetic enhancement of anthropogenic soils (Dalan 2006:162-163).

Because of its ability to help delineate magnetically enhanced areas associated with cultural activity (Gaffney and Gater 2003:151 and Figure 81), sometimes revealing individual architectural elements (Lockhart 2007:105 and Figure 4.9), this technique has become increasingly useful for archaeo-geophysical investigations. Magnetic susceptibility instruments differ from magnetometers in that they only measure fields resulting from induced magnetism, as compared to a magnetometer that records the net effect of induced and remnant magnetism (Dalan 2006:162; Kvamme 2006b:207-210). The differences between these two instruments produce data sets that are both complementary and unique. They are complementary in that magnetic susceptibility data can aid in the interpretation of magnetometer data (Dalan 2006:162-163), and how magnetic susceptibility data is unique in that it can be used to address entirely different research questions, such as tracking broad magnetic changes across the landscape (David 1995:20).

Like conductivity, Magnetic susceptibility has the potential to produce archaeogeophysical results that are quite similar in appearance and information content to that obtained by magnetometer surveys. One of the best examples of this is from the Tom Jones site (3HE40), a 14th-15th century Caddo mound center in southwestern Arkansas (Dalan 2006:182 and Figure 8.9; Lockhart 2007). Dalan has repeatedly demonstrated magnetic susceptibility's utility in addressing both soil characterization and site formation issues (Dalan and Banerjee 1998; Dalan 2006, 2008).

MULTIPLE TECHNIQUES

As noted earlier the best strategy to employ to increase the potential success of an archaeo-geophysical survey is to use multiple instruments (Kvamme 2003a, 2003b, 2006a, 2007). Multiple instruments "sense" different physical properties of the soil and are differentially and adverse effected by extraneous modern cultural debris and metal. The current state of the art for using multiple geophysical instruments, as championed by Kvamme (2006d), consists of employing a series of statistical models and algorithms to combine these multiple data sets into what he has termed a GIS fusion.

Lockhart's work at the Tom Jones site (Lockhart 2006, 2007a; Schambach and Lockhart 2003) is perhaps the most compelling illustration of this point. Lockhart demonstrated that using a suite of geophysical instruments in the same archaeological survey areas, including fluxgate gradiometery, electromagnetic induction (magnetic susceptibility and conductivity), resistance, as well as GPR, helped tease out archaeological nuances in the deposits and features preserved there that were not legible in any one single data set.

Field Methods

Archaeo-geophysical field methods and survey logistics have been thoroughly described by Clark (1990:158-164), Gaffney and Gater (2003:77-101), Somers and Hargrave (2003), and Bevan (1998). These sources, especially Gaffney and Gater (2003), provide important overviews of many variables that can help or hinder an archaeo-geophysical field project. The discussion that follows highlights those aspects of geophysical field methods that are directly relevant to the density of the data collected and not the larger issues of survey logistics.

Field methods for archaeo-geophysics varies in detail from technique to technique, but there are several factors that are consistent with all techniques. The density of the dataset is controlled by two factors: (1) traverse interval—the distance between the passes the instrument makes as it is passed back and forth across the collection area; and (2) sample interval—the distance between readings the instrument records as it passes along each traverse. There are standard starting points for these settings, but ultimately this depends on many factors, including the size and depth of the archaeological targets, the nature of the sediment matrix, land use of the collection area, duration of the survey, as well as the investigative scope of the research design.

The specific technique for recording data also varies from instrument to instrument. In general there are three major collection strategies: (1) Gridded Collection, (2) Timed Collection, and (3) Instrument-guided collection. Deciding which collection strategy to use depends on the constraints of the instrument as well as the specific needs and goals of the archaeogeophysical project.

GRIDDED COLLECTION

Gridded collection is mostly used on instruments designed specifically for archaeological use, in particular with instruments from British manufacturers such as Bartington Instruments and GeoScan Research. These instruments require that the instrument be programmed to collect a specific number of readings over a specific number of traverses and then be structured so that the collection pace matches these parameters. This results in a regularized or gridded dataset with no need for additional gridding or data interpellation steps to be taken prior to data processing. The main limitation to this approach is if the collection pace strays from the set parameters, then that data needs to be deleted and recollected, or additional data processing steps must be completed to account for the misplaced data points.

TIMED COLLECTION

With timed collection the geophysical instrument is set to record a specific number of readings per second. Data is then collected by either walking at a set pace, resulting in regularized datasets, or by simply collecting the data and later using software to regularize or grid the data. This produces data with an irregular number of readings down the traverse, and regular interval spacing between the traverses. Instruments manufactured in the United States and Canada (such as the Geometrics 858 cesium magnetometer and the Geonics EM38 and EM31 conductivity meters) use a timed collection strategy. They are generally quicker to use in the field and require less site preparation; however, the data points tend to be less precisely positioned with timed collections in comparison to gridded ones.

INSTRUMENT GUIDED COLLECTION

Global positioning system (GPS) collections are a good example of an instrument-guided collection strategy in archaeogeophysical research. GPS collections simply use a differential GPS system to add a three-dimensional location to each data point. With the use of real time kinematic (RTK) GPS systems, less than 1 cm accuracy is possible for each grid point. This allows the field survey to be collected with extreme quickness and efficiency. The major limiting factor with GPS guided collection is the need for a clear view of the sky. RTK systems are improving quickly, however, but to maintain a continual "fixed" position there must be a relatively clear view of the sky, and forested areas and urban canopies greatly limit the use of this strategy.

SAMPLE DENSITY, SURVEY SPEED, AND DATA QUALITY

Sample density is perhaps the most important variable controlled by the archaeo-geophysicist during data collection. Sample density refers to the number of readings recorded in the field. It consists of two variables: (1) the Sample Interval, or the number of readings taken as the surveyor moves back and forth along each traverse, and (2) the <u>Traverse Interval</u>, or the distance between each traverse. Sample density can be expressed as a single number—as in 16 readings per m—or more specifically as two numbers (as in 0.125 x 0.5 m), which express the relationship between the sample and traverse intervals –

Sample density of a collection most directly affects the pace of an archaeo-geophysical survey. More specifically, the traverse interval has the greatest impact on survey speed. Changing the sample density has minor implications, with differences in survey speed mostly concerning data volume. For example, collecting data with a 0.5 m traverse interval takes twice as long as data collected with a 1.0 m traverse interval, whereas the only difference in survey time between data collected at a sample interval of 1 reading/m or a sample interval of 8 readings/m is the frequency at which data is downloaded from the instrument when it is full (usually only taking several minutes). Sample density also has the most direct impact on the resolution of the geophysical data. Thus, there is a trade off between speed and resolution.

There is no "one size fits all" approach to archaeo-geophysics. It is also not accurate to assume that higher resolution images will be worth the extra time that must be spent in the field to collect them. Sample density should be considered as a flexible variable determined by the nature of the archaeological target, the surrounding geological context, as well as the ground cover present at the time of the survey. This is not a new or even novel concept for archaeologists and can be observed at many levels in modern archaeological field practices. For example, in archaeological survey, surveyors typically rely on the most time-efficient methods that are suitable for the given region in which the survey investigations are being conducted. Depending on the survey conditions, this can range from aerial photo analysis, to surface collection, to shovel testing. The same concept should be considered in the application of archaeo-geophysics in a particular project setting. Given the nascent understanding of archaeo-geophysics in the context of developing and appreciating the appropriate investigative scale of focus when compared to traditional archaeological practices, it is virtually a given that finding the correct sample density and survey speed variables to employ in specific archaeo-geophysical investigations will come through empirical testing in different archaeological and landscape situations.

Data Processing

The data collection techniques discussed above have dramatically different workflows for post-collection data processing. All data must be processed and filtered to remove extraneous false readings (spikes and drop-outs). Processing levels the datasets so adjacent collection grids can be combined into a single image with no “grid lines.” Datasets should be processed to enhance the visibility of any target features through statistical manipulation of the recorded data as well as through image processing of the image file output.

The general goal of data processing is to lessen the effects of background “noise” and to enhance the quality of the “signal” or “target” in the geophysical data. In field geophysics in general, and archaeo-geophysics in particular, the term noise is used to discuss any return that is not a direct result of the object under investigation, this being referred to as the “target” or “signal.” Hence, in some cases what is discussed as noise can in another case become the signal or target (Milsom 2005:13-14). The general approach to data processing follows Kvamme (2006c:236), namely to computer process the geophysical data to identify regular and culturally interpretable patterns using pattern recognition principles: “In general, anomalies exhibiting regular geometric shapes (lines, circles, squares, rectangles) tend to be of human origin” (Kvamme 2006c:236). After each processing step the results should be closely compared to their previous processed state to assure that data manipulation is not in fact decreasing the clarity and quality of the data, and thus avoiding the creation of processed images that are primarily products of the data processing itself.

CHAPTER 3 - THE ETOWAH SITE

Introduction

This chapter presents the findings of geophysical surveys at the Etowah site (9BR1) in Bartow County, Georgia (Figure 3.1), conducted during the summers of 2005, 2006, 2007 and winter 2008. Multiple geophysical techniques were used in both mound and village context to locate several special use structures, defensive features, and old excavation units. This is a collaborative research project supported by a private research grant from the Lannan Foundation and is also supported by Archaeo-Geophysical Associates, LLC, the Muscogee (Creek) Nation of Oklahoma, the Center for the Study of Arts and Symbolism of Ancient America at Texas State University, and the Savannah River Archaeological Research Program. The field crew has included students from the University of Arkansas, the University of South Carolina, Texas State University at San Marcos, the Muskogee (Creek) Nation of Oklahoma, the Art Institute of Chicago, and the University of Texas at Austin. Adam King of the University of South Carolina, Chester P. Walker of Archaeo-Geophysical Associates, LLC, and F. Kent Reilly of Texas State University direct the project.

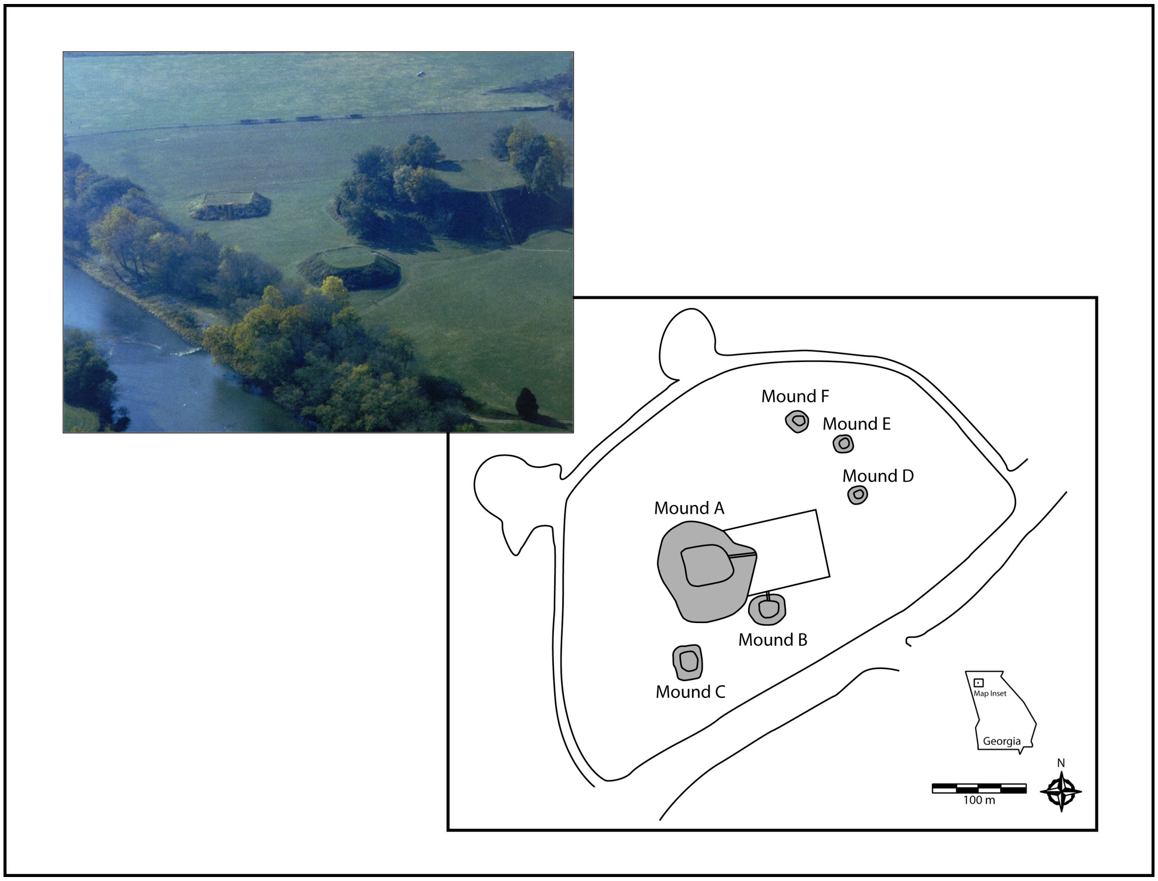

Figure 3.1 The Etowah Site (9RB1)

A Fluxgate gradiometer was used to collect over 16 ha of geophysical data from the summits of five mounds (A, B, D, E, and F) and a large portion of the site's village. The geophysical survey has located many features of the prehistoric landscape at the Etowah site including domestic structures, mound top precincts, house compound plaza groups, and defensive structures (Figures 3.2, 3.3 and 3.4). The data in this chapter has been previously presented in technical reports (Walker et al. 2006, 2008a) as well as in numerous conference presentations (Sharp et al. 2005; Schultz et al. 2006; McKinnon et al. 2007; Walker et al. 2008b).

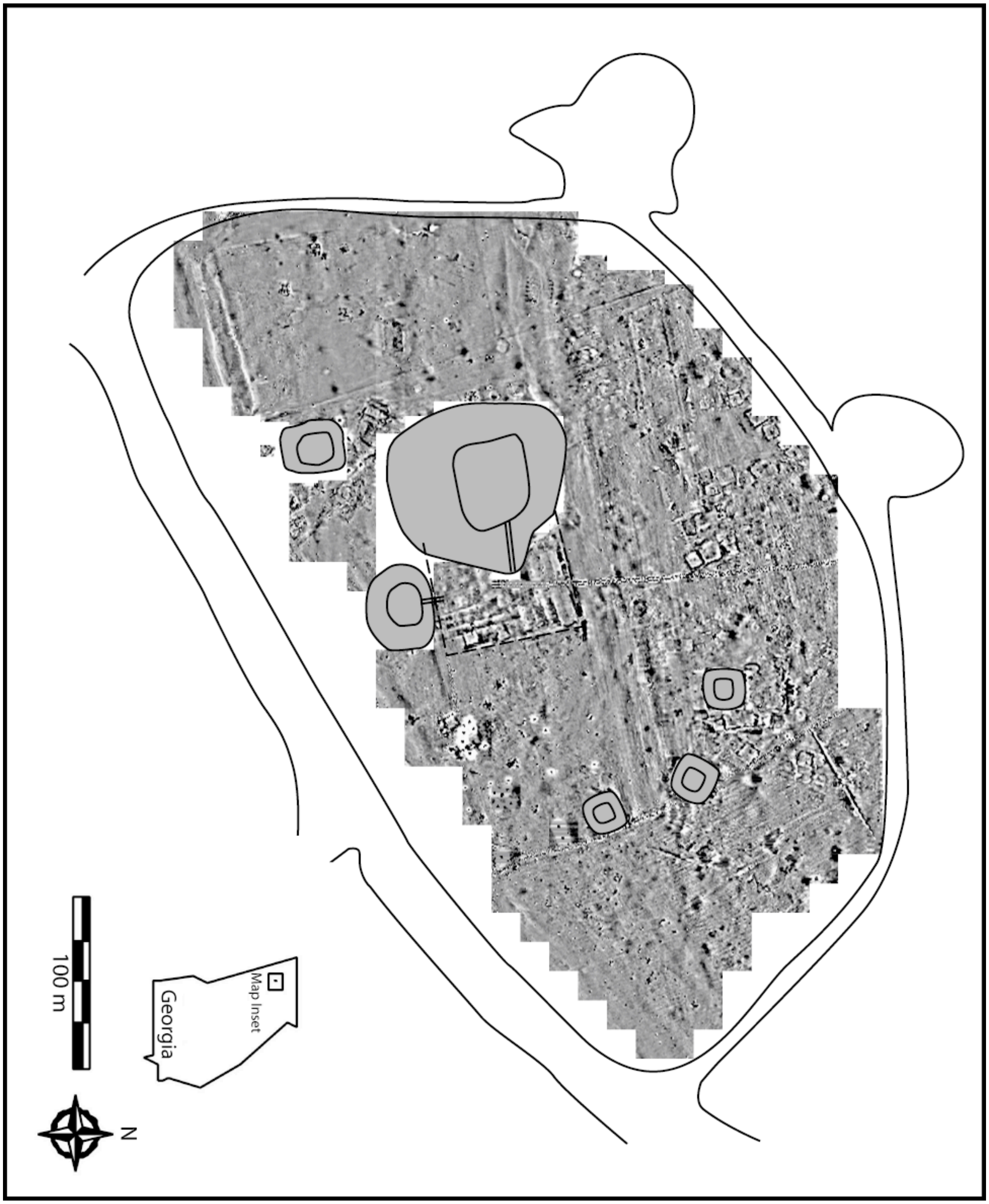

Figure 3.2. Grayscale plot of the gradiometer data from the Etowah site.

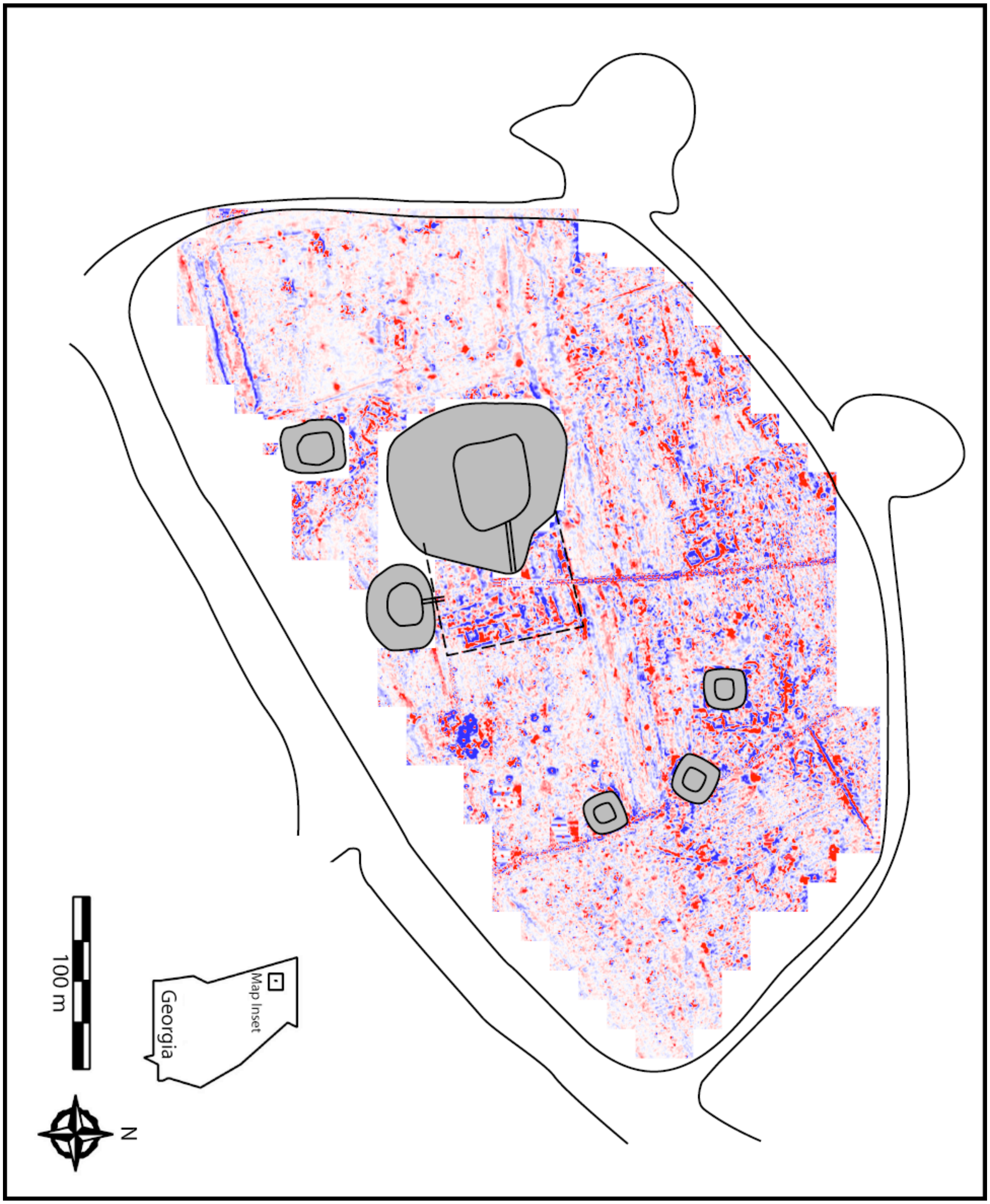

Figure 3.3 Color plot of the gradiometer data from the Etowah site.

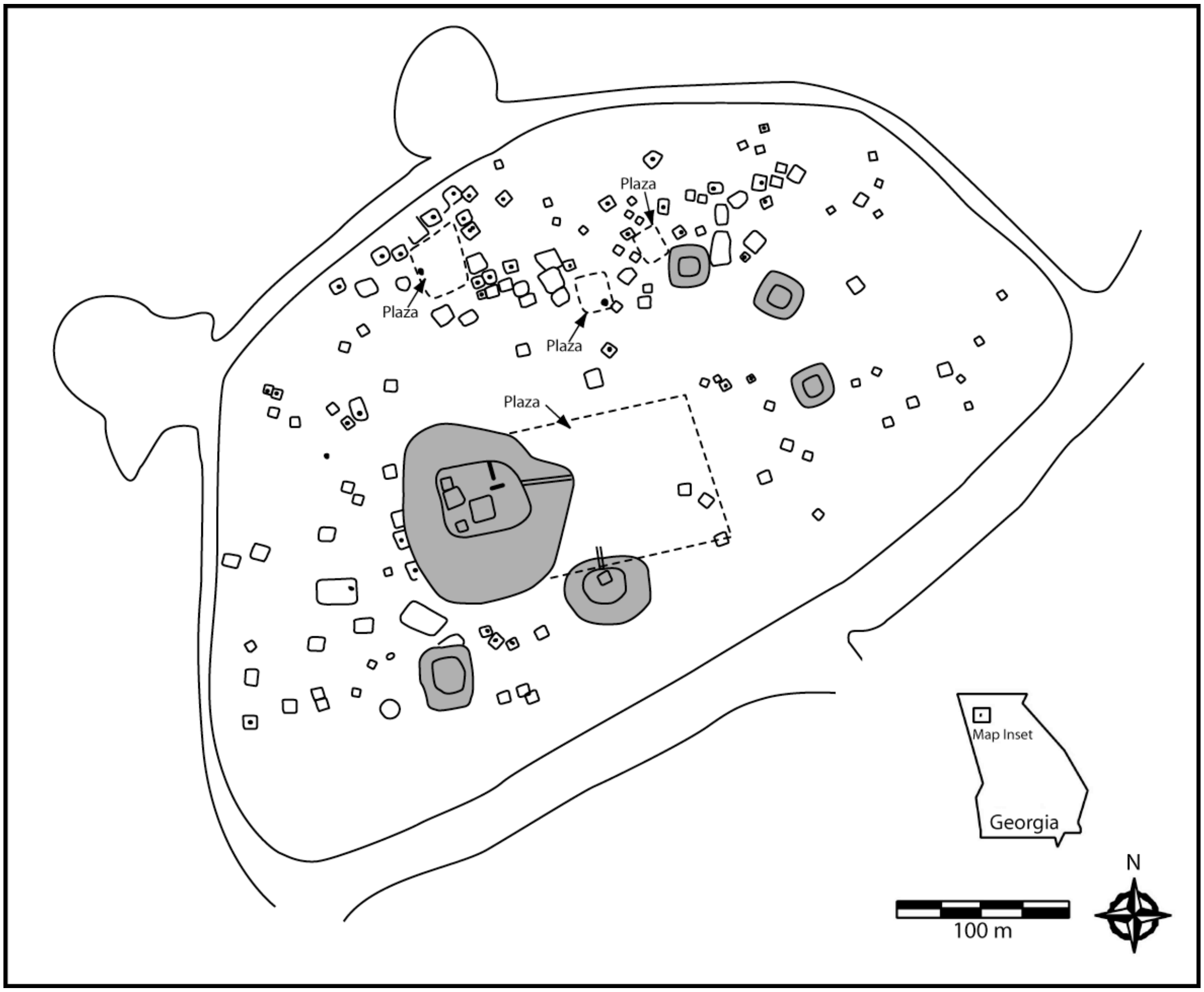

Figure 3.4 Interpretative map of the gradiometer data from the Etowah site showing the locations of prehistoric architectural features.

Archaeological Research at Etowah

The Etowah site is a multi-mound Middle Mississippian village dating from A.D. 900 to A.D. 1650 (see for King [2003a] for the most recent synthesis of the archaeological findings at the Etowah site) located northwest of present day Atlanta, Georgia. The Etowah site is owned and maintained by the Georgia State Parks Departments and is known as Indian Mounds State Park.

John P. Rogan conducted the first recorded excavations at Etowah in

1883 on behalf of Cyrus Thomas (1894) of the Bureau of Ethnology. Rogan's excavations concentrated on Mound C and to a lesser extent Mounds B and E. Between 1925 and 1927, Warren K. Moorehead (1932) of the Phillips Academy conducted additional investigations at Mounds C and B, as well as in several parts of the village areas west of Mound C and East of Mounds A and B. In preparation for the State of Georgia's purchase of the site, William Sears (1958) systematically tested the areas between Mounds B and C and east of Mounds A and B in 1953. The following year, A. R. Kelly of the University of Georgia began five years of excavations focusing on the western flank of Mound B (Kelly and Larson 1957; King 2001).

That same year, Lewis H. Larson, Jr. began excavations for the Georgia Historical Commission on what remained of Mound C (Larson 1971, 1989, 1993; King 2003b), and those investigations lasted until 1962. Through the mid-1960s and into the 1970s, Larson also conducted excavations in village areas east of Mounds A and B, at the ditch to the north of Mound A, and at Mound D (Larson 1972; King 2003b). In 1980, Morgan R. Crook of West Georgia College made systematic surface collections between Mounds D and E and the ditch. A field crew working for the Georgia Department of Natural Resources investigated small areas at the base and summit of Mounds A and B in preparation for the construction of new visitor access stairs in 1994, while in 1995 another crew excavated a block at the edge of the ditch to prepare for a new bridge across the palisade ditch (King 1995).

Despite the fact that professional archaeologists have worked extensively at Etowah, there are many limitations in the archaeological data that have been obtained in the various hand-controlled excavations. Key among these limitations is the fact that most of the excavations at the site have focused on the mounds or areas adjacent to mounds. The entire site has never been systematically investigated through archaeological excavations. As a result, a clear archaeological picture does not exist concerning how the entire site was used and how those uses may have changed with time. For example, it is not possible to identify and understand how the size and settlement density of residential zones, and by extension population size, changed over time. It also remains unclear as to whether there are other specialized burial areas, outside of the site's burial mound (Mound C), that could contain clues as to the development of social ranking at the site. Neither is it clear whether elites had specialized architecture and residential areas at Etowah. Finally, it remains to be determined if craft production took place in special areas of the site or can be associated with particular residential zones or "neighborhoods."

A second important factor limiting our ability to understand the layout of the site comes from an inability to fully understand the results of previous excavations. Rogan (Thomas 1894), Moorehead (1932), and Larson (1972, 1989) all conducted fairly extensive excavations in non-mound areas at the site. Unfortunately, the precise location of the various excavation units has been lost either because of poor recording techniques or the impacts of time on records, collections, and the location of internal site datums. In order to fully exploit the information gathered by these efforts, the findings within these earlier excavations need to be placed within the larger context of the entire site.

Archaeogeophysical Investigations at Etowah

The fieldwork objectives of this project were to both assess the potential of incorporating geophysics into future archaeological research efforts at Etowah as well as to gather useful archaeological information on the spatial character of the site's archaeological deposits. The first field objective was successfully accomplished during our first field season (Walker et al 2006). Since then, the remaining field work has been focused on gathering as much archaeological information as possible through non-destructive geophysical survey. A systematic survey of the entire site using a fluxgate gradiometer was completed in January 2008.

Field Methods and Data Processing

Geophysical data at Etowah was collected in a series of 20 x 20 m grids. Magnetic data was collected using a 1 m traverse interval and a 0.125 m (8 readings per m) sample interval. A 100 x 100 m grid was established using a total data station. Tapes were used to establish the corners of the 20 m collection units. Non-magnetic markers of alternating color were placed every 2 m to guide collection. Data was collected at a pace of 1.3 m/second.

All data were processed and filtered to remove extraneous false readings (spikes and drop-outs) and to level the datasets so adjacent grids are combined into a single image with no "grid lines." Kvamme (2006c:236) methodologically was followed in the general approach to data processing of the Etowah geophysical data. After each processing step the results are closely compared to their previous state to assure that data manipulation is not in fact decreasing the clarity and quality of the data, and thus avoiding the creation of erroneous geophysical artifacts of data processing.

ArchaeoSurveyor 2.0 by DW Consulting was used for data processing. Magnetometer data was clipped ± 10 nT to increase its contrast and enhance the legibility of the archaeological features. A zero median de-striping filter was also used to remove grid lines and the striping caused by the differences in the balance of the two sets of fluxgate sensors. The data set was also destaggered to correct for minor inconsistencies in survey speed.

Survey Results

The magnetometer data from Etowah demonstrate how archaeogeophysical research can increase our understanding of its architectural variation and intra-site layout as well as how the various features of the site were situated on the landscape. These kinds of observations about architectural and mound features, and their spatial relationships, are being made at other sites across North America with increasing frequency (cite), among them the Caddo data sets presented later in this dissertation.

TYPES OF HOUSES AND CRITERIA USED IN THEIR INTERPRETATION

The magnetometer data from Etowah includes many anomalies (n=140) that can be clearly and reasonably interpreted as prehistoric archaeological structures. There is a considerable amount of variation in the types of anomalies that are being interpreted as structures. This variation is a result of the range of architectural forms that were constructed at the site through its long occupation as well as different post-depositional processes that have been acting on these structures since their construction.

Figure 3.5 illustrates examples of the basic anomalies at Etowah currently being interpreted as structures. Type 1 (Figure 3.5.1) is a complex dipole signature that is rectangular in shape. This anomaly type (n=40) represents approximately 28.6% of the total number of possible structures identified to date at the site. Type 2 structures (Figure 3.5.2) are rectangular anomalies (n=__) comprised of linear dipoles. Some have mono-polar highs in their center. Type 2 anomalies (n=94) comprise approximately 67% of the total number of possible structures. Type 3 (Figure 3.5.3) structures are similar to Type 2 structures except they are defined by weak positive magnetic rectangular patterns with low magnetic centers. This type (n=6) represents 4.3% of the total number of possible structures. Type 4 (Figure 3.5.4) anomalies are essentially a sub-class of the Type 2 anomalies in that they are series of overlapping or adjacent Type 2 anomalies. There are five Type 4 anomalies and they are included in the over all counts with the Type 2 anomalies.

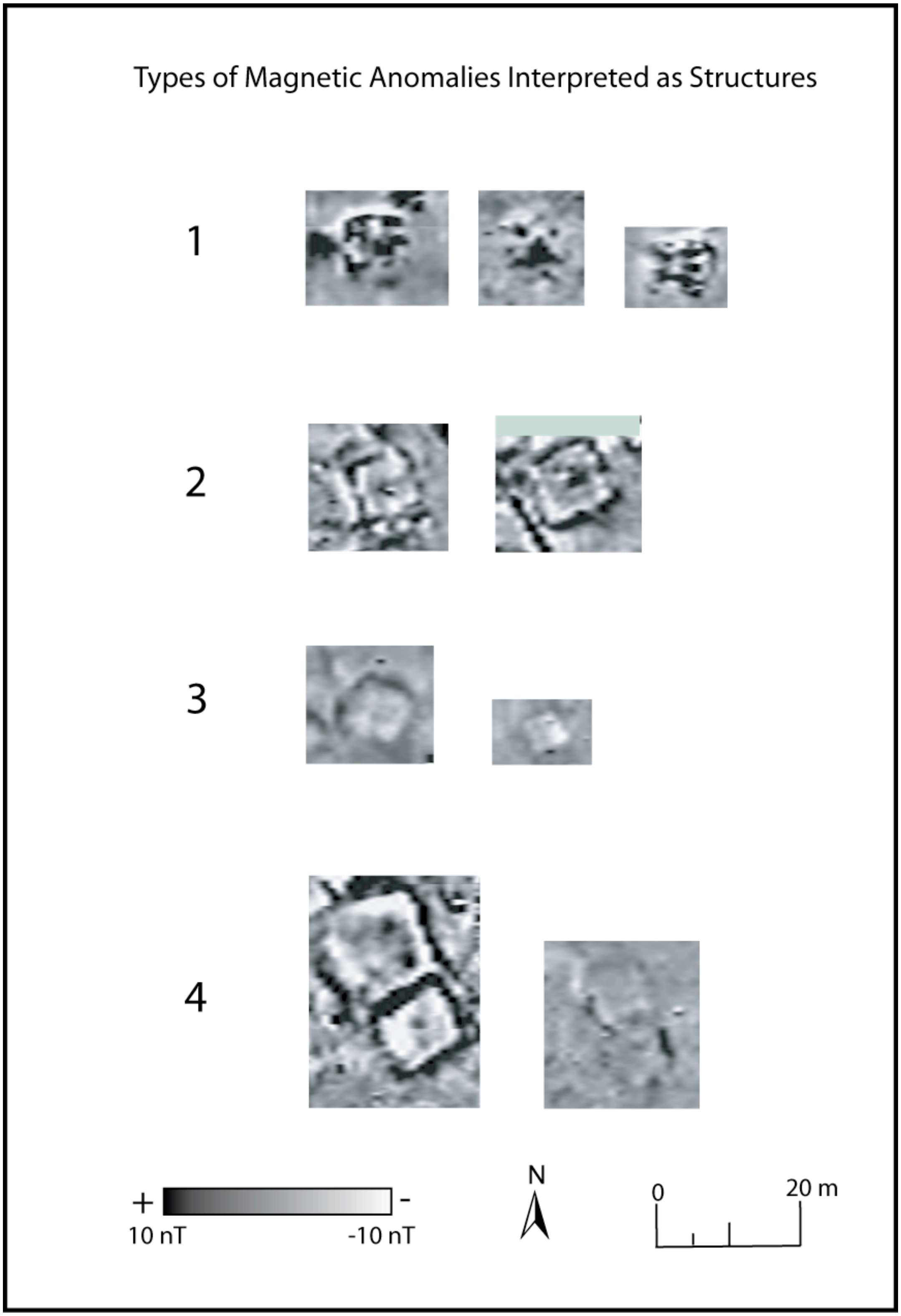

Figure 3.5 Geophysical signatures of the various types of structures from the Etowah site.

Several of the Type 2 structures contain a circular high return in the center of the anomaly that is being interpreted as a thermally altered features or central fire hearths due to their positioning within the structure as well as their magnetic signature. There are hundreds of similar high magnetic anomalies in the data set that are not associated with Type 2 structures. Figure 3.6 shows the distribution of the positive magnetic anomalies not associated with Type 2 structures. These magnetic high returns do cluster around areas of the site where there are more Type 2 structures. Many of these positive magnetic anomalies more than likely represent the central hearth of a structure that is not geophysically legible due to either post-depositional processes or to the fact that they were in a structure that was not burned. It is possible that these positive magnetic anomalies may also represent a range of negative relief features such as storage pits, burial pits, outdoor cooking hearths or ovens; they may also be geological in nature. A sample of these positive magnetic anomalies should be targeted for ground truthing in order to determine their origins.

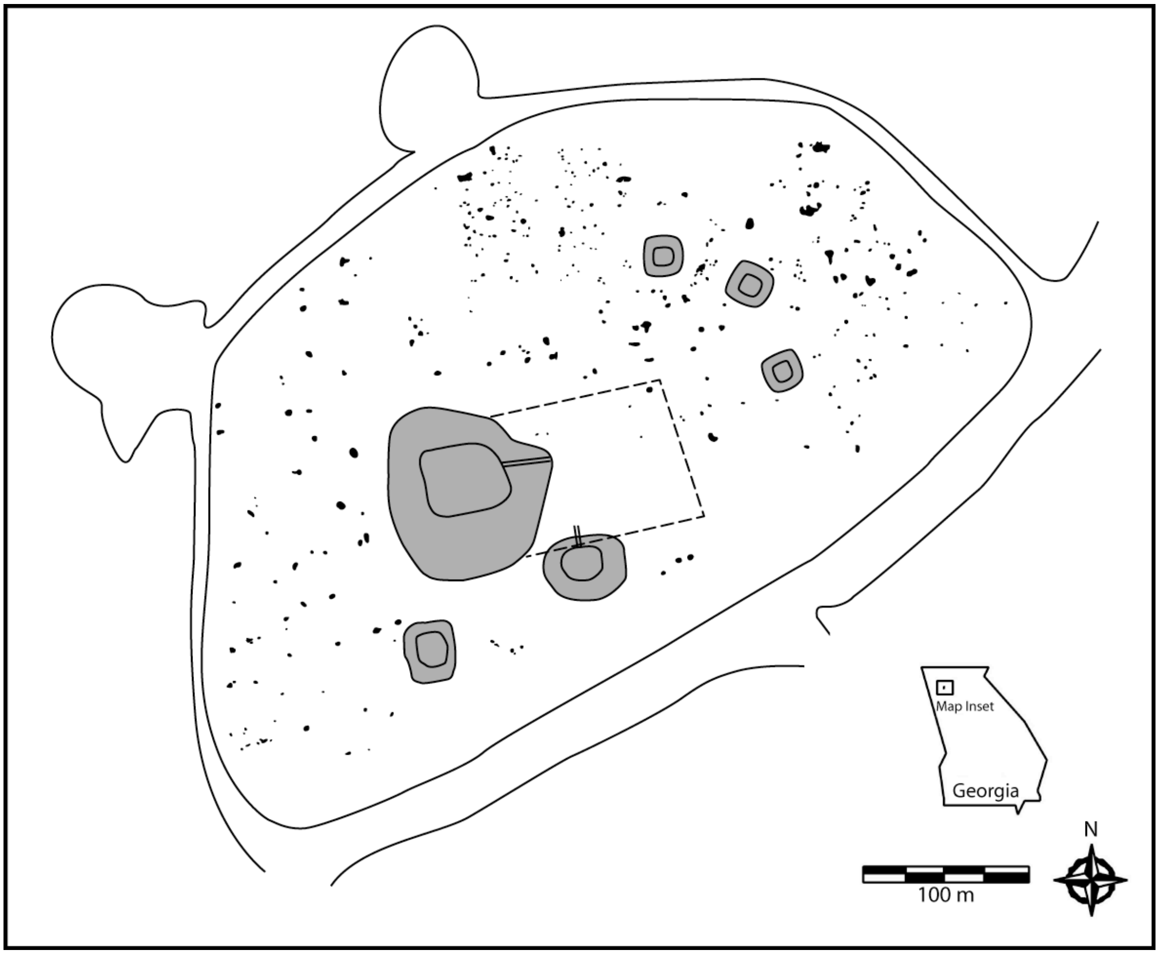

Figure 3.6 Distributions of Positive Magnetic Anomalies at the Etowah Site.

Modern Cultural Anomalies

Even if an archaeological site is well stratified (either horizontally or vertically) and easily defined into a series of components with distinctive temporal and spatial boundaries, magnetometer data creates a palimpsest of information. This is due to the nature of magnetic mapping, which creates a single image of the net sum of magnetic fields, regardless of their depth, age, or origin. The first order of business when attempting to recognize and define the prehistoric anomalies in the magnetic palimpsest that is the Etowah site is to identify the trends and anomalies that appear to be the result of modern cultural or geological activity. In many cases these trends can provide useful information regarding the nature of the prehistoric archaeological deposits. For example, if intensive plowing is obvious by repeated low contrast to high contrast linear anomalies in geophysical data, one should expect to see evidence of this disturbance on the prehistoric deposits. The pattern well known to Southeastern U.S. archaeologists of parallel plow scars running across an otherwise well preserved house floor can often be visible in the geophysical data.

Figure 3.7 shows the level of modern cultural activity that has produced legible features in the magnetometer data. The most obvious are the long linear anomalies that traverse the site from north to south as well as east to west. The north-south running linear anomaly to the west of mounds A and C is a pair of twisted telephone lines that are above ground as they cross the Etowah River. The east-west running parallel linear anomalies appear to have similar signatures as the telephone lines, but they have not been ground truthed. These may indeed be telephone lines or the result of deep plow scars. There is a general trend noted in the data to the west of the park road of high frequency linear anomalies that run parallel to these two east-west oriented anomalies noted in Figure 3.7. These high frequency anomalies are no doubt the result of repeated plowing. In the area to the east of the park road, there is a similar high frequency linear pattern; however, these follow a north-south orientation, suggesting that these two areas were plowed in different directions.

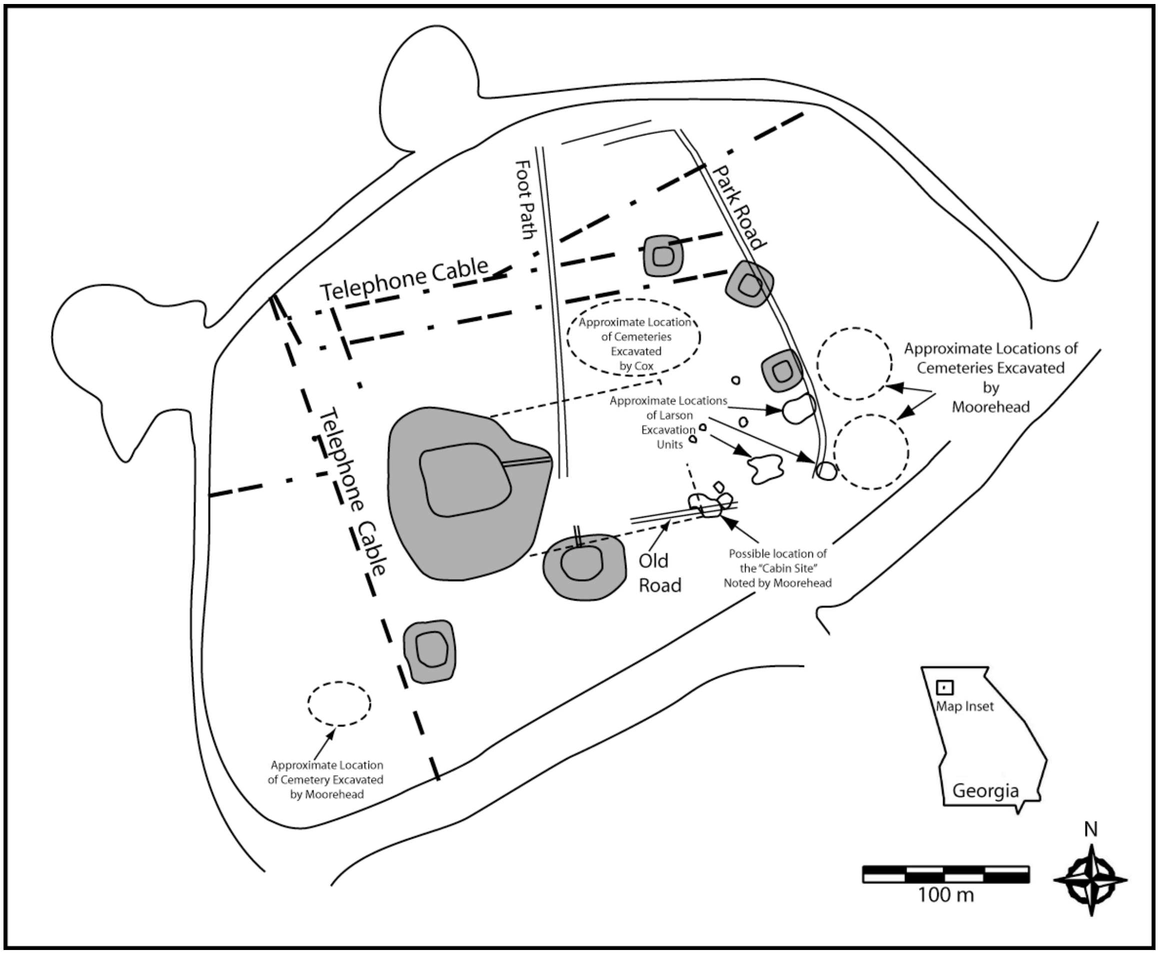

Figure 3.7 Modern Historic anomalies identifiable in the gradiometer data from the Etowah site.

Other notable signs of modern cultural activity are the series of high amplitude magnetic returns located in the center of the southern edge of the collection area (Figure 3.2) These strong “bull’s eye” dipoles are often caused by archaeological trash. The age-old habit of archaeologists leaving their corner spikes in back-filled units will be the continued burden of the archaeogeophysicist[1].

There are several possibilities that can explain these dipoles. Moorehead (2001:91 and Figure 59) noted a good deal of exploration on both sides of the

[1] For those reading this – please switch to non-ferrous corner markers, brass, aluminum, PVC, or wood. This goes for wire pin flags also!!

bend in the road. Larson also excavated a large block directly to the south of Mound D (King 1995). The two easternmost clusters of dipoles more than likely relate to the metal trash left behind by these two archaeological projects. The cluster of dipoles to the west of these dipoles could also be the result of archaeological trash but also may represent the accumulation of metal artifacts from an historic structure. Moorehead (2001:91 and Figure 59) noted a historic structure in this general area that he referred to as the "cabin site." He went on to describe this site as consisting of slag, partly melted iron, and large bricks (Moorehead 2001:95). All make excellent magnetometer targets. Moorehead (2001:95) concluded that a former plantation owner's attempt to smelt iron was indeed the origin of the "cabin site."

East of the bend in the road is a large grave lot with two main clusters (see Figure 3.7). Moorehead plotted over 50 burials in this area as well as a "burned burial" containing eight individuals, a burned floor, and several whole ceramic vessels (Morehead 2001:91 and Figure 59). Also plotted on Moorehead's map directly to the west of the village mounds is an area marked "Excavated by P. E. Cox." A grave lot is also plotted in this area that contained at least 15 individual interments, an urn burial, and a large burned floor. A grave lot located approximately 30 m to the west of Mound C continued at least 12 individuals and a hearth (Moorehead 2001:92 and Figure 61).

Geological Trends

Geological trends are most legible on the southern edge of the collection area (Figure 3.2). These trends are most likely the result of fluvial activity of the nearby Etowah River. The most dramatic geological trend in the geophysical data is the edge of the T1 alluvial terrace that is just to the north of Mound A. This terrace shows up in the data as a broad linear anomaly that traverses the entire data set on an east to northeast trajectory. The geophysical data to the north of this linear anomaly—hence on the T1 terrace—has a higher contrast than the data to the south of this linear anomaly and off the T1 terrace. This trend is most apparent in the north-south running telephone cables discussed above. As the telephone cable runs north to south its magnetic signature is noticeably dampened or magnetically quieter. This is perhaps due to the presence of alluvial overburden capping the southern portion of the site. This trend also has an observable impact lowering the intensity of the magnetic signature on some of the prehistoric anomalies in this southern portion of the site, especially the area to the west of mounds A and C.

MOUND A

King (1995) conducted the only recorded excavations on the summit of Mound A. Two 2 x 3 m units were excavated at the extreme northern edge of the summit. Portions of this area had been eroded away and rebuilt after the site became a state park. In other portions of the area, King recovered daub and midden indicative of an intensive occupation of the summit. The deposits had clearly been plowed and this supports reports by the site's original owners that the summit was used to grow watermelons during the late 19^{th} and early 20^{th} centuries (King 1995). During that time, a mule team plowed the mound summit.

In early June 2004 on the first day of the Etowah Archaeogeophysical Survey (EAS) four 20 m collection grids were collected on the summit of Mound A, recording a complex series of at least four summit top structures (Figure 3.8).

Of these, two clearly are Type 1 structures (Mound A structures 2 and 3) and two are Type 2 (Mound A structure 1 and 4) structures. These four structures are described in more detail below.

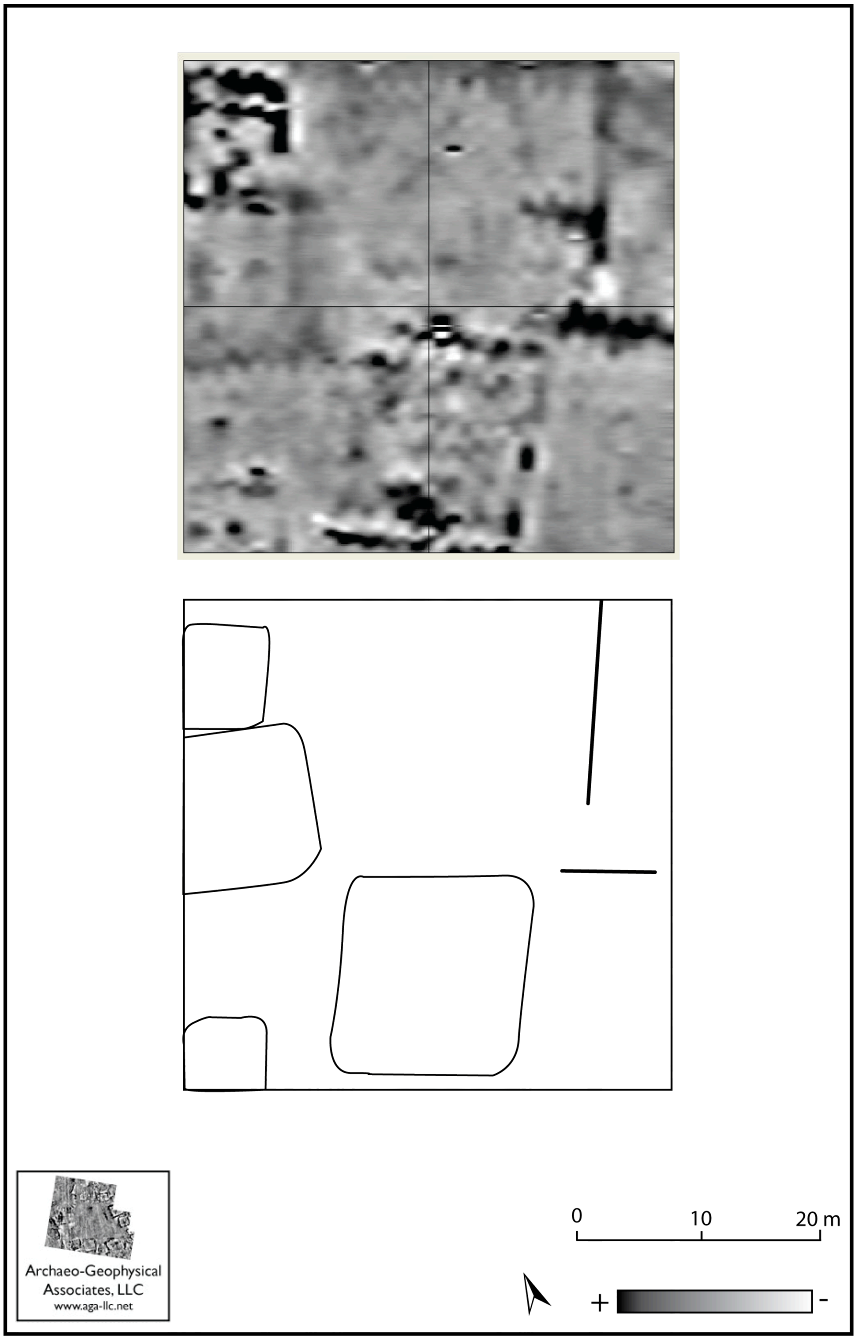

Figure 3.8 Mound A Structures

Mound A Structure 1, the largest of the four identified structures, is located at the center of the south side of the summit. It is approximately 18 X 18 meters and is aligned parallel to the south face of the mound. While it may have internal features, the interior is apparently largely open and undivided, with a portico or porch in front of it on the east side (Figure 3.8).

Mound A Structure 2 is clearly indicated in the northwest corner of the Mound A summit. It is rectangular, aligned north-south with the west face of the mound, and is approximately 10 x 12 m in size. Based on the general dimensions of domestic structures at Mississippian sites in this region (Sharp et al 2006; King et al ND) a structure this size would itself be perhaps twice the size of a conventional residence in the village. This building appears to have been rebuilt and to have interior partitions.

The third subsurface feature on Mound A lies adjacent to the first and just west of it, occupying the southwest corner of the summit. Mound A Structure 3 not complete, however, it appears to be a rectangular structure that is approximately 6 x 8 m in size, roughly the size of a small residence.

There are, in addition, several other features on the Mound A summit. In the northeast quadrant of the mound, running north-south for approximately 17 m, is a screen or wall; then behind that, to the west, there is a short stretch of wall or baffle and another clearly defined stretch of wall running east-west for approximately 8 m, almost in the center of the east face of the mound. The north-south stretch of screen, in combination with Mound A Structure 1 and Mound A Structures 2 and 4, create an open courtyard, with evidence of a central post pit.

To date, the Mound A summit data have been analyzed and scrutinized in more detail than any other portion of the site. Researchers from the EAS have presented several conference papers specifically on this data (Schultz et al 2006; Sharp et al 2006) as well as a journal article (King et al., in press). These works all draw on broad comparisons across the region regarding the patterning of mound summit architecture. A general architectural pattern is well noted in the region for mound summits to have had multiple contemporaneous structures (Sharp et al. 2006). The age and specific use of these structures on the summit of Mound A will be the subject of future EAS research.

MOUND B

The summit of Mound B has been investigated on three separate occasions. Rogan excavated a "12ft square" unit in the center of the mound, supposedly all the way to the original ground surface (Thomas 1894). In the 1920s, Moorehead (1932) excavated a second unit on the summit, measuring 6 by 8 feet. In 1994, King (1995) excavated a small block at the northern edge of the summit, exposing the last summit surface, where features containing Lamar period pottery and daub were encountered.

The geophysical data from the summit of Mound B shows evidence of a considerable amount of disturbance from old excavation units, spread out backfill, or other archaeological disturbances, although it is difficult to discern exactly what type of disturbance (Figure 3.9). A strong di-polar return is present in the northwestern corner of the block that is more than likely the result of a buried metal object left by earlier archaeologists. There is a promising linear anomaly on the northern edge of the data that runs north to south. This linear anomaly is approximately the same dimensions as several of the structures recovered in the village. Figure 3.9 shows a hypothesized structure on Mound B. Due to the disturbance noted in the northwest corner of the grid, ground truthing will be necessary to confidently determine if this linear anomaly is indeed the remnants of a structure.

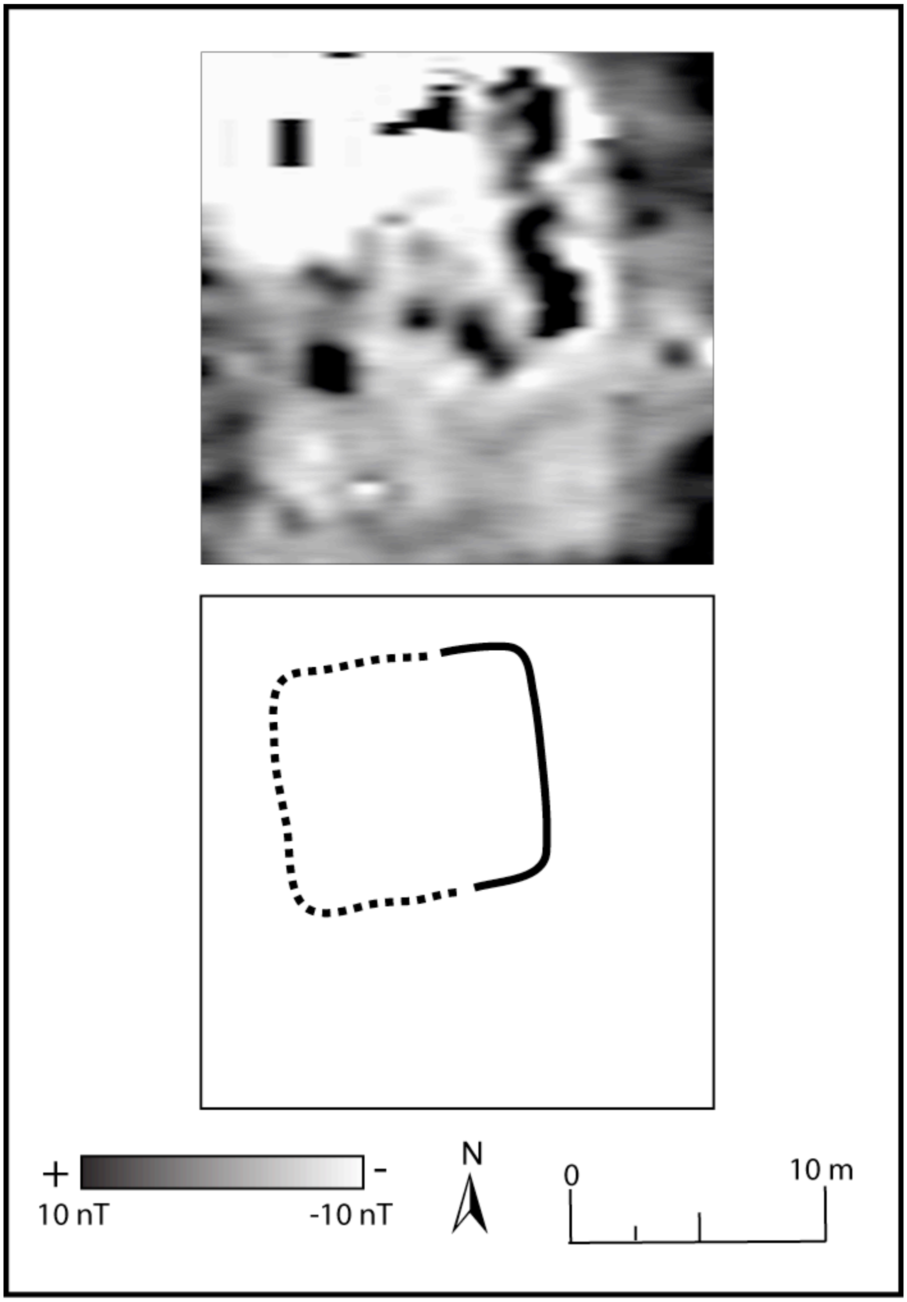

Figure 3.9 Geophysical Data from the Mound B Summit

THE VILLAGE

To date 386 geophysical grids totaling 15 hectares or 38 acres have been collected across the Etowah village. Approximately 140 possible structures have been located in this effort. The three village mounds (D, E, and F) are all legible in the geophysical data to varying degrees. Areas in between Mounds A, B, and C appear to be the location of a series of structures and possible pits or midden deposits. West of Mound A are several large structures and small structures. The most notable clusters of structures are directly to the north and northeast of Mound A where a series of houses are organized around several small plazas. The area west and southeast of Mound A also has structures, but they are much less common than they are in the north and northwestern portions of the site.

There are several intriguing spatial patterns in the distributions of Type 1 (rectangular shaped complex dipole anomaly) and Type 2 structure anomalies with respect to the overall layout of the archaeological community. Figure 3.10 shows the distribution of Type 1 magnetic anomalies or possible structures. They are clearly more frequent in areas to the west and the southeast of Mound A. Type 1 structures also are more randomly distributed than the Type 2 structures: they are more widely spaced across the site with the exception of the area to the northeast of Mound A.

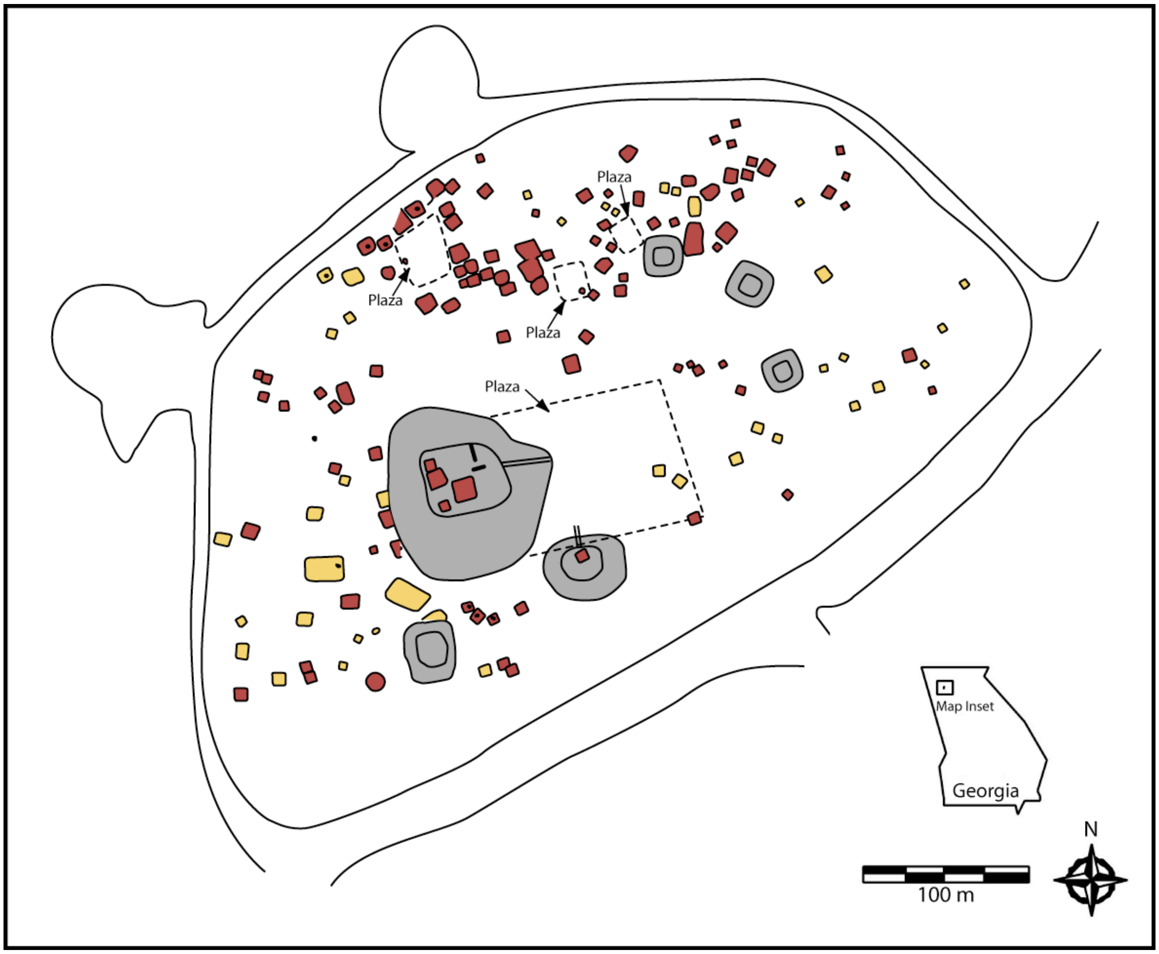

Figure 3.10 Distributions of Type 1 (yellow) and Type 2 (red) Structures identified in the Gradiometer survey.

The distribution of Type 2 structures (Figure 3.10) is quite different than that of the Type 1 structures. Type 2 structures are densely clustered in the area to the northeast of Mound A and are organized into at least three small plazas or courtyards that are defined by the regular arrangements of structures positioned around an area with less magnetic activity. Outside this core cluster, Type 2 structures are also broadly distributed across the site, often in smaller mini-clusters of two to four structures. They are not found as often in an isolated or stand alone pattern such as is the case with the Type 1 structures.

At the village level in the front (west side) of Mound A is a magnetic trend that is neither clearly interpretable nor repeated anywhere else at the site. This trend is comprised of a series of roughly north-south running linear dipoles in its southern two-third and a series of east-west running linear dipoles in its northern one-third. This trend may be the result of the basket-loaded clay-lined plaza noted by Sears (1958:94-107) in this area. The exact dimensions of this clay-lined plaza are not known, but it has often been speculated (Sears 1958) that it extended much farther to the east than does the geophysical pattern discussed here. The Sears/Plaza hypothesis may also be supported by the fact that Sears' excavations were placed close to the base of Mound A, suggesting the basket-loaded clay lining he encountered was indeed the same deposit that has created the complex magnetic trends.

PLAZA GROUPS

Three small plaza groups are noted in the main cluster of Type 2 houses to the northeast of Mound A (see Figure 3.5). Figure 3.11 is a detail of the most clearly interpretable of these plaza groups. Closer inspection of this plaza group demonstrates the degree to which community organization at the Etowah site is portrayed in the magnetometer data. Rows of houses flank the sides of a central plaza that measures approximately 40 m east-west and 50 m north-south. In the center of the plaza is a good example of the high frequency east-west running magnetic trend that is the result of the repeated parallel plowing of the site. There is also a positive magnetic high anomaly just off center on the western edge of the plaza. This may be the location of an outside fire pit used in public rituals or events.

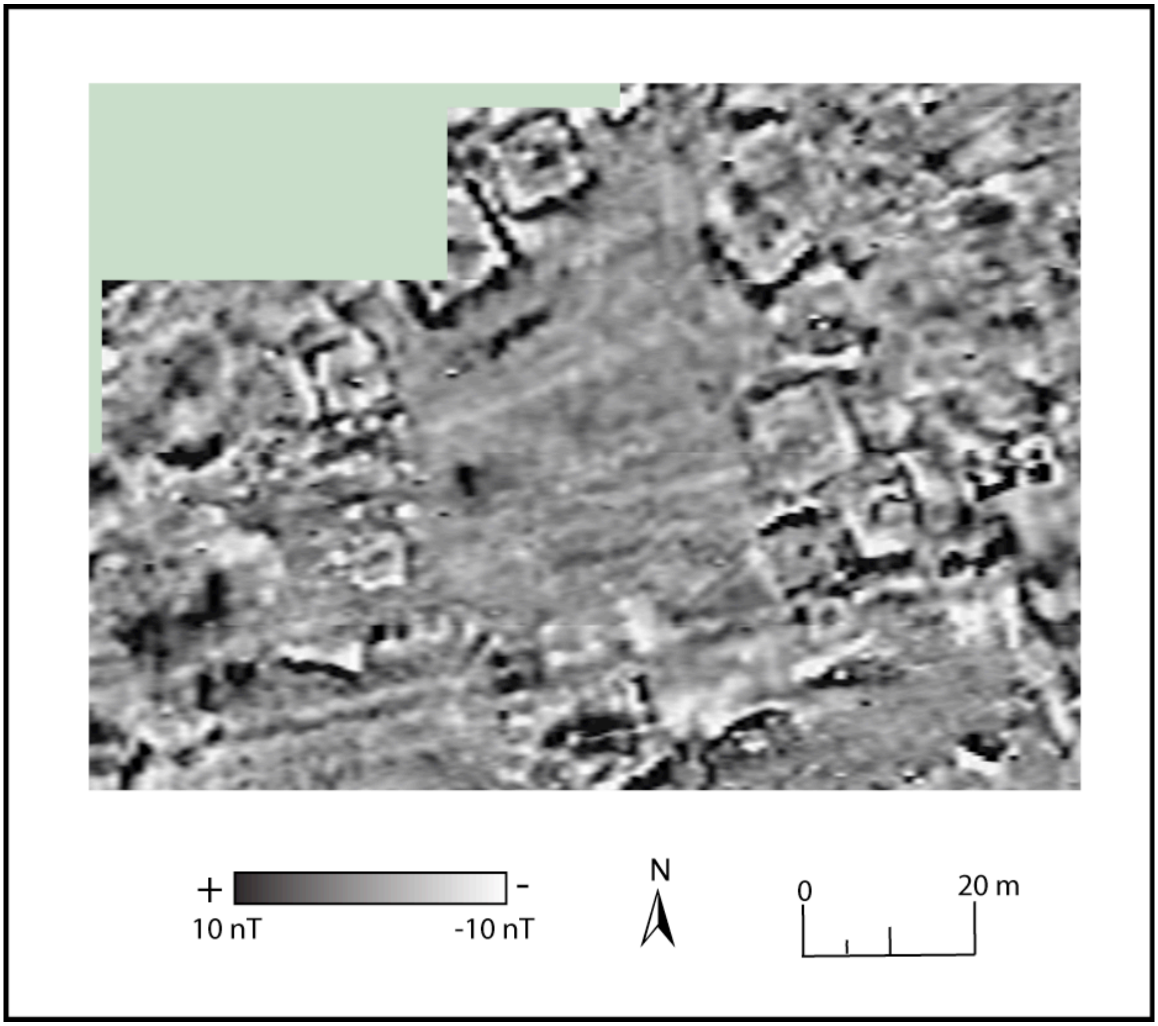

Figure 3.11 Etowah's northern plaza group.

The obvious complexity of the general nature of the magnetometer data in the eastern plaza groups is apparent in Figure 3.12. The areas flanking the central plaza obviously witnessed a persistent rebuilding of structures. This combined with modern activities, such as agricultural practices; make the identification of individual structures difficult. The anomalies interpreted here as structures only represent the best candidates for structures based on the basic size shape and form of the anomaly. It seems very likely that significantly more structures were present at the site than are identified in the present magnetometer study (see Figure 3.4).

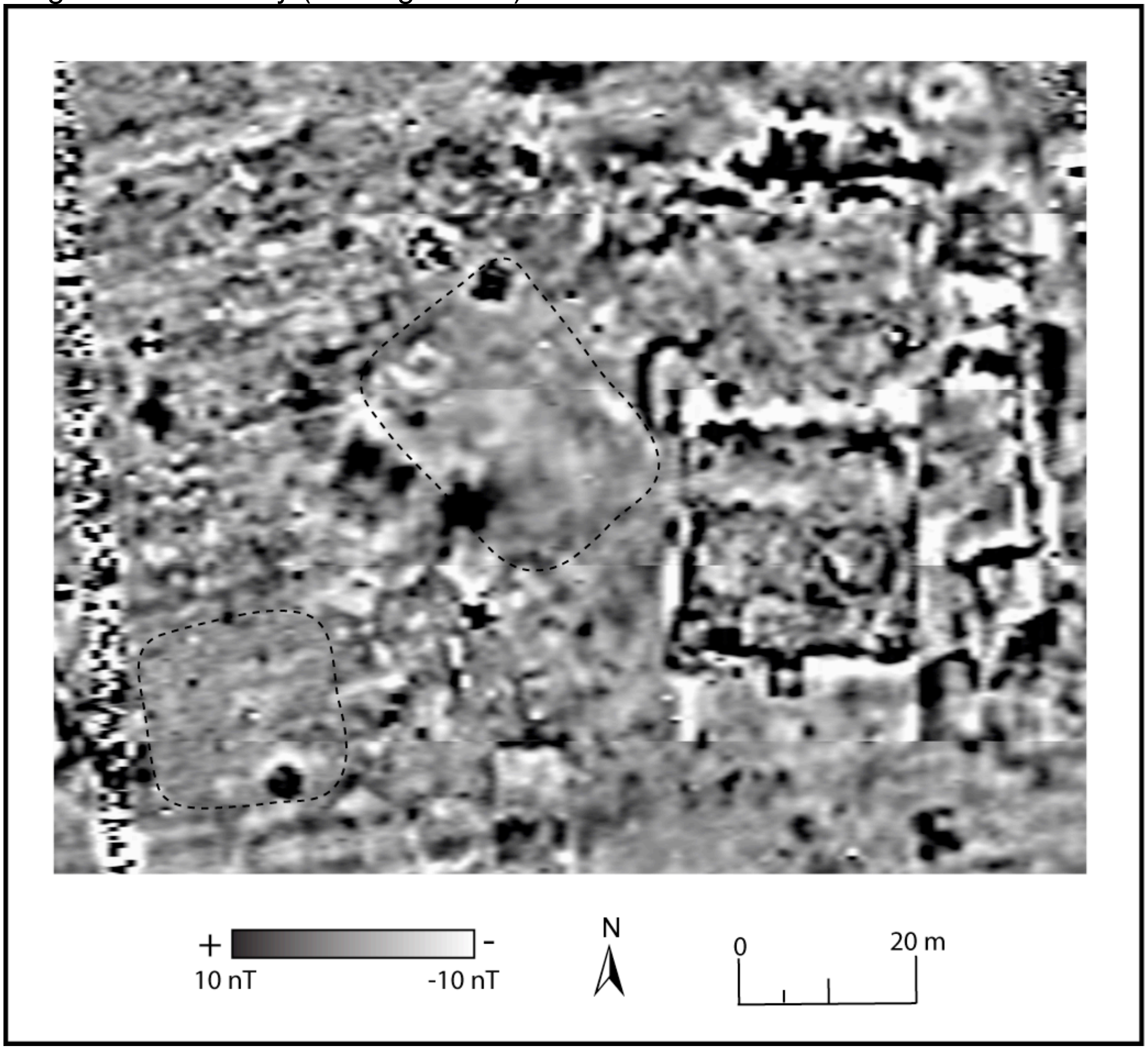

Figure 3.12 Eastern Plaza Groups

VILLAGE MOUNDS

The three village mounds named D, E, and F, are arranged in an arc to the northeast of Mound A (Figure 3.13). Of these three mounds, the area of Mound F has the most legible magnetometer data, being defined by a large (approximately 22 X 22 m) square pattern of linear dipolar anomalies. The northern edge of this pattern is a linear anomaly with a high dynamic range resulting in a strong dipole that appears to have a diffuse negative magnetic trend on the side facing away (to the north) from the mound. There is a great amount of magnetic complexity on the northwest and eastern sides of the mound and an even greater amount of complexity present in the interior of the overall magnetic pattern. This internal complexity is most likely the net effect of repeated mound summit architectural construction, perhaps at different construction phases of the mound, as well as previous excavation units. On the center of the southern edge of Mound F is a small square projection that extends out approximately 2m.

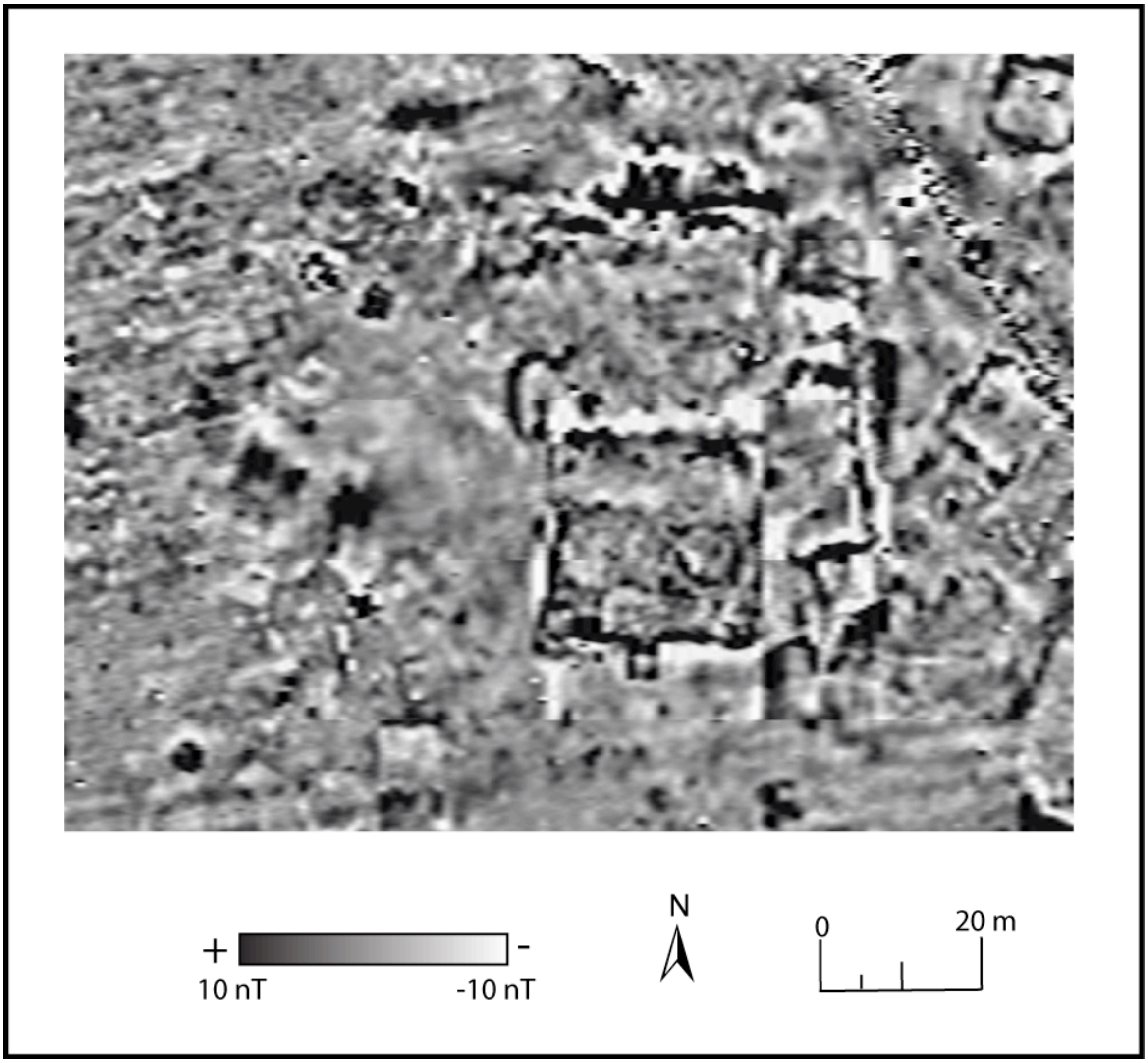

Figure 3.13 Mound F

Mound E is orientated on a northeast axis and is less legible than Mound F. Mound E is partially defined by linear dipoles that comprise segments of its southwest and northwest sides. Similar to Mound F, there is a complex pattern of magnetic activity on the interior of Mound E's edges. The park road clips the northeast corner of the mound.

Mound D is the least legible of the three village mounds. This mound also happens to have been the most intensively excavated of the village mounds.

Both Larson and Moorehead excavated portions of Mound D. Larson's excavations provided the stratigraphic and ceramic data that currently are employed to place the three village mounds in the more recent Brewster phase (AD 1475 – 1550) of the occupation at Etowah (King 2003a:81).

IN BETWEEN MOUNDS

The area in between mounds A, B, and C has been excavated on at least two occasions, first by Sears (1958:58-59) and then by Larson (King 2003a:81). Neither of these excavations are well mapped nor extensively reported. King (1996, 2003a) used Larson's unpublished field notes as well as Sears's report to conclude that the area in between the three mounds has a complex history that ranged from an elite courtyard during the Wilbanks phases (Early, A.D. 1250-1325; Late, A.D. 1325-1375) to its later use as a feasting area as noted by several large storage and trash pits (King 2003a:61-83).

Magnetometer data from this area (Figure 3.14) suggests the presence of several Type 2 structures between mounds A and C as well as to the northeast of Mound C. The area east from Mound C to Mound B is a magnetically quiet area; the nature of the magnetic signature of this area as well as its location between Mounds A, B, and C suggests the possibility of a courtyard or plaza.

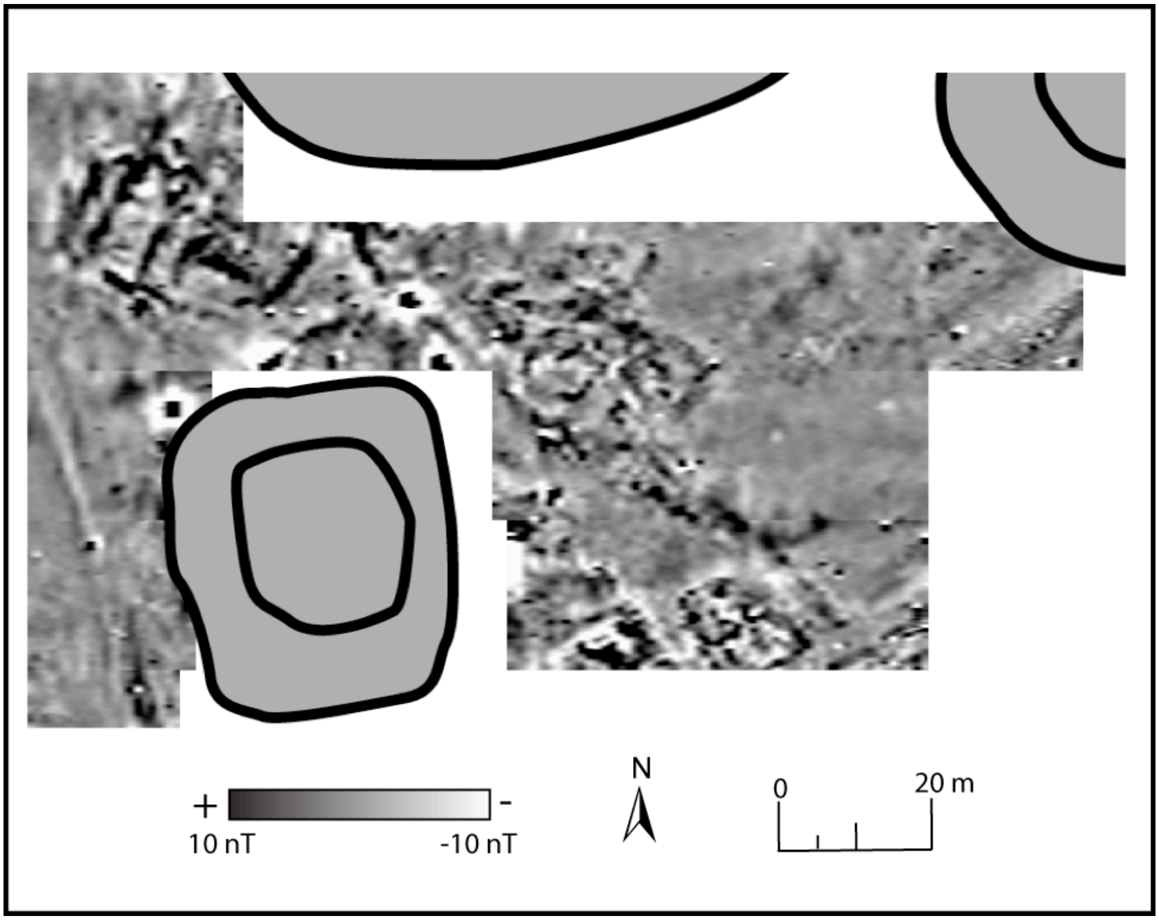

Figure 3.14 Area between Mounds A, B, and C.

To the northeast of Mound C, directly to the southeast of Mound A, is a large interwoven complex series of linear dipolar anomalies. These linear dipolar anomalies may represent a single large (30 x 20 m) building or a series of smaller rebuilt houses.

MOUND A'S BACKSIDE

One of the most difficult areas to clearly interpret is the area directly behind and in part underneath Mound A (Figure 3.15). Directly at the mound's base are several obvious structures represented by either Type 1, 2 or 3 anomalies. Based on the well known findings by Larson (1971) and others that the extensive elite mortuary of Mound C extended into the sub-mound ground level (Ref?), several of the positive magnetic high magnetic returns on the northern portion of Figure 3.15 may well have been caused by human interments. Larson's (1971:60) interpretation of the Mound C mortuary suggests that at the base of Mound C—directly above the large community sub-mound structures (Larson's structure 3, 5. and 7)—was an outer ring of human interments.

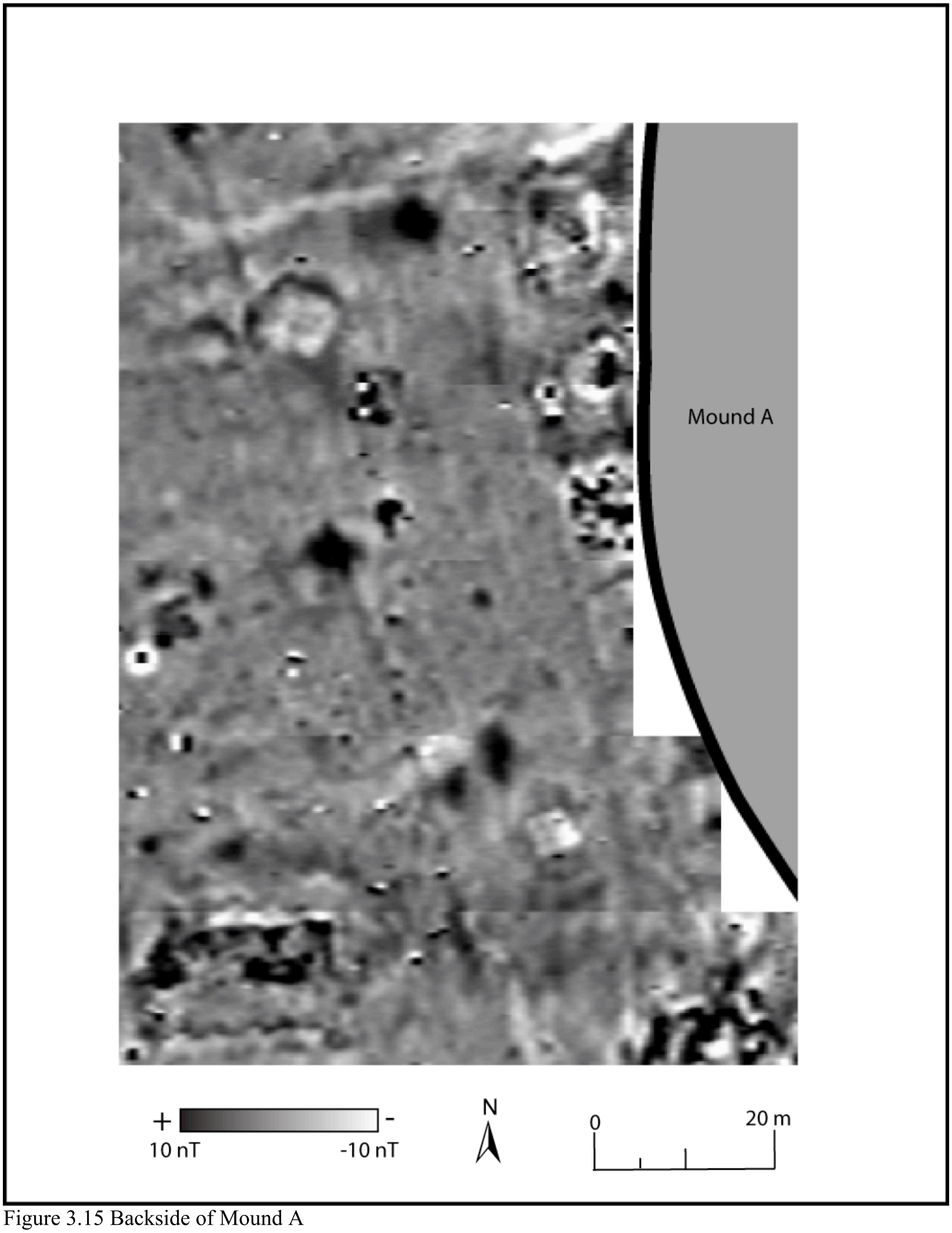

Figure 3.15 Backside of Mound A

Summary of the architecture and Archaeology

Given the amount of excavations that have been conducted at the Etowah site there is a surprisingly small number of domestic structures available for comparison of architectural constructions employed here. This is mainly due to the fact that the vast majority of the professional excavations at Etowah have focused on the main elite precinct directly adjacent to the site's three main mounds. There are, however, a few good candidates for comparison that were excavated in the sub-mound C excavations.

Figures 3.16 and 3.17 are Larson's structures 4 and 6 (King 2003a:56 and Figure 6). These two structures are of inset post trench construction and measure approximately 5 x 7 m. This is thought to be the typical architectural style of the Etowah phase (Early, A.D. 1000-1100, and Late, A.D. 1100-1200) (King 2003a:52-60). There is variation in the presence or absence of a central fire hearth; a hearth is present in Larson's Structure 4 (Figure 3.15) but absent in Structure 6 (Figure 3.16). The general dimensions and architectural details of these two structures strongly suggests that this is the architectural form associated with our Type 2 anomalies.

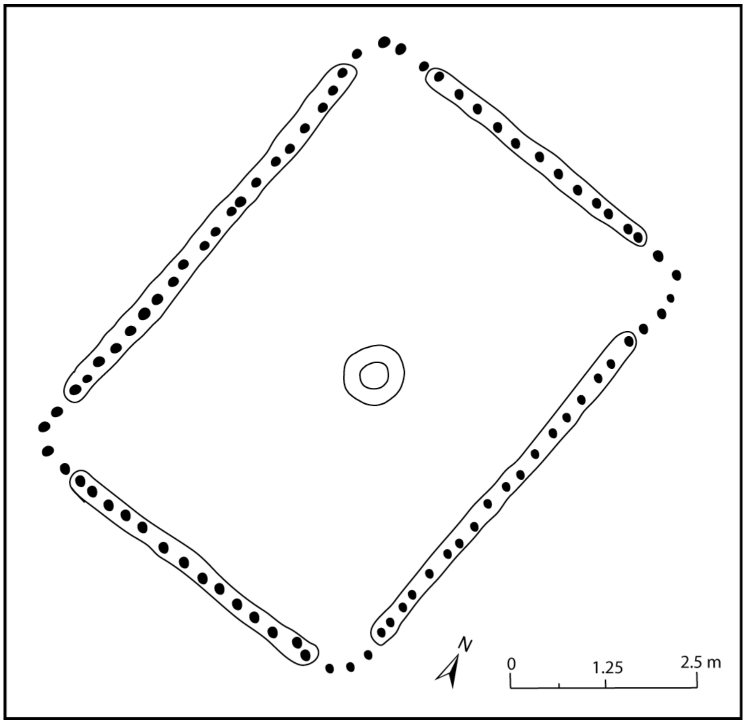

Figure 3.16 Structure 4. After King 1996:84

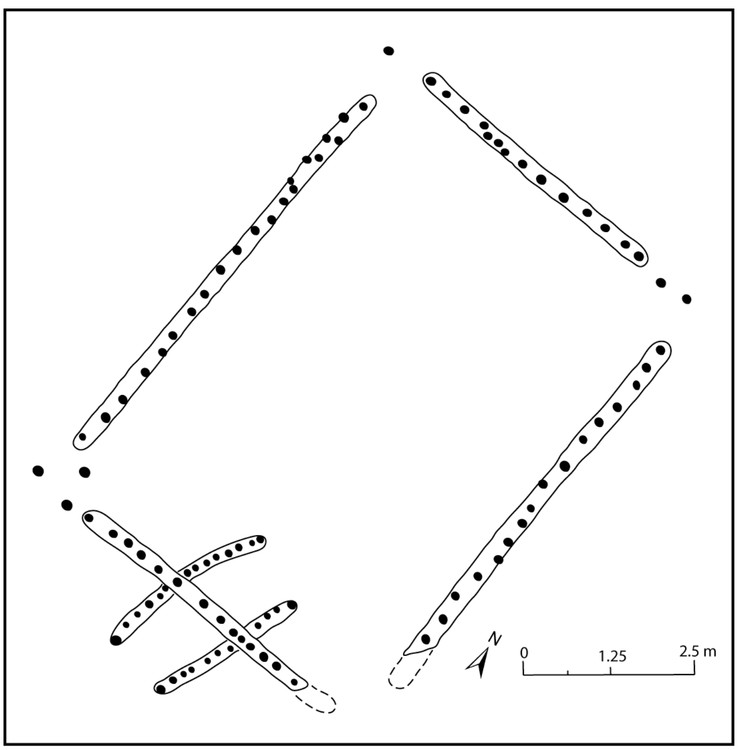

Figure 3.17 Structure 6. After King 1996:85.

Later archaeological phases at Etowah are well defined by changes in architectural forms that have been demonstrated from other sites in the region (Lacquement 2004:124-131). The Brewster phase (in this case the Brewster phase, dating from A.D. 1475-1550) seem to have had single set post constructed structures (Figures 3.18 and 3.19) with no well defined wall trench (King 2003a:81-83), as in the structure Larson excavated directly to the south of Mound D (Figure 3.18) and Sears excavated east of Mound B (Figure 3.19). Both of these structures exhibit a great amount of internal construction activity, and the structure south of Mound D also had a prepared clay floor. This architectural form could well produce a magnetic signature similar to the Type 1 anomalies.

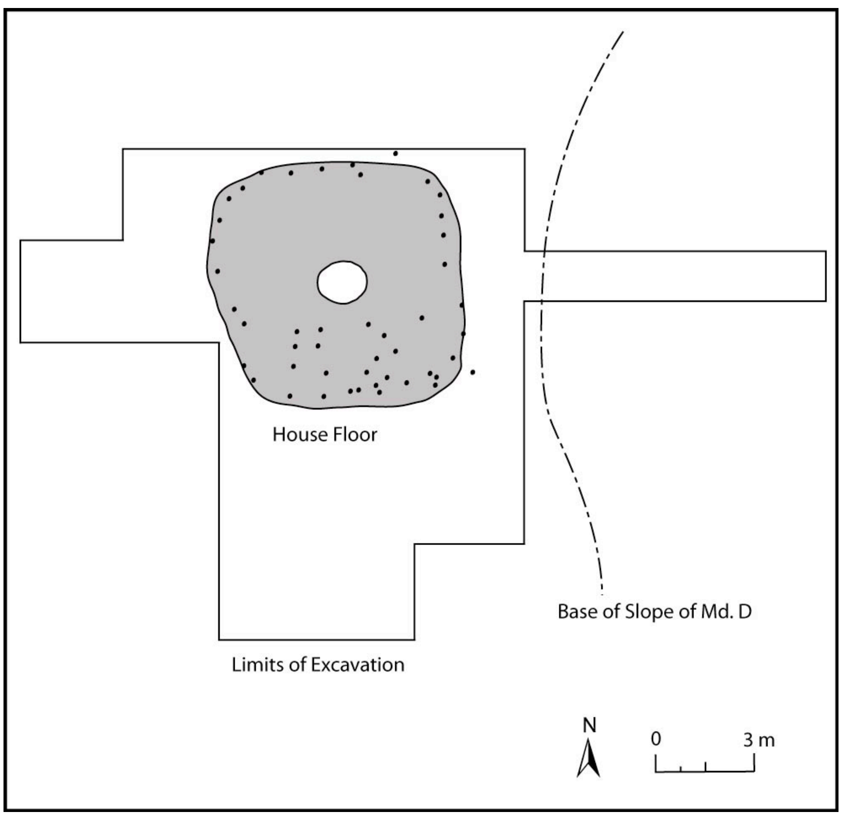

Figure 3.18 Structure from Mound D. After King 1991.

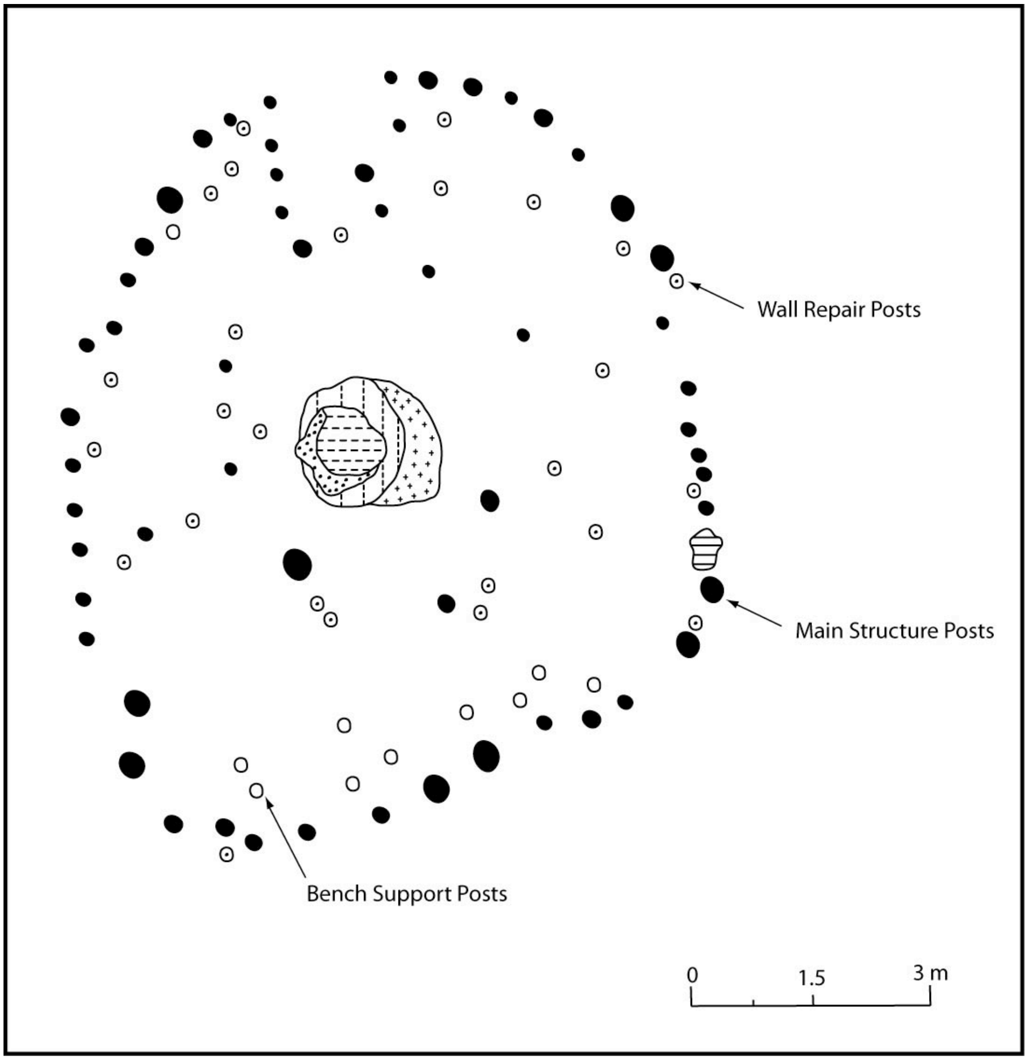

Figure 3.19 Brewster Phase Structure excavated by Sears. After King 1996:128.

The third major archaeological phase at the Etowah site, the famous Wilbanks phase (Early, A.D. 1250-1325; Late, A.D. 1325-1375), does not have a clearly defined architectural form as do the earlier Etowah and the later Brewster phases. However, it is widely believed that the Wilbanks phase houses were more closely comparable to the later single post Brewster phase houses (King, personal communication).

There is compelling evidence based on the construction sequences of mounds A, B, and C, as well as grave lot material recovered in the Mound C excavations, that the elite precinct of the Etowah site quickly reached its peak during the Early Wilbanks phase and then quickly collapsed during the Late Wilbanks phase (King 2003a:63-81). This begs the obvious question regarding our admittedly oversimplified binary architectural division. Was there an overlap in architectural forms during both parts of the Wilbanks phase or perhaps a more nuanced architectural grammar was present where each archaeological phase included a range in architectural forms and styles? Perhaps the architectural constructions at this time during the occupation of the Etowah site crosscut both geophysical anomaly structure types as well as the current and conventional understandings of architecture gained through archaeological excavations.

A single circular structure was identified in the magnetometer data in the area to the southwest of, but in the immediate vicinity to, Mound C. Kelly excavated a circular structure measuring 12.8 m in diameter (Figure 3.20) in a palisaded compound directly adjacent to Mound B (King 2003a:64). This structure had a central fire hearth and was encircled by a ditch and embankment. The comparison of this structure to Kelly's circular structure is certainly strengthened by the close proximity of each of them to mounds B and C. King (2003a:64-65) suggests that Kelly's circular structure represents an open walled building such as those noted in historic Creek period square grounds.

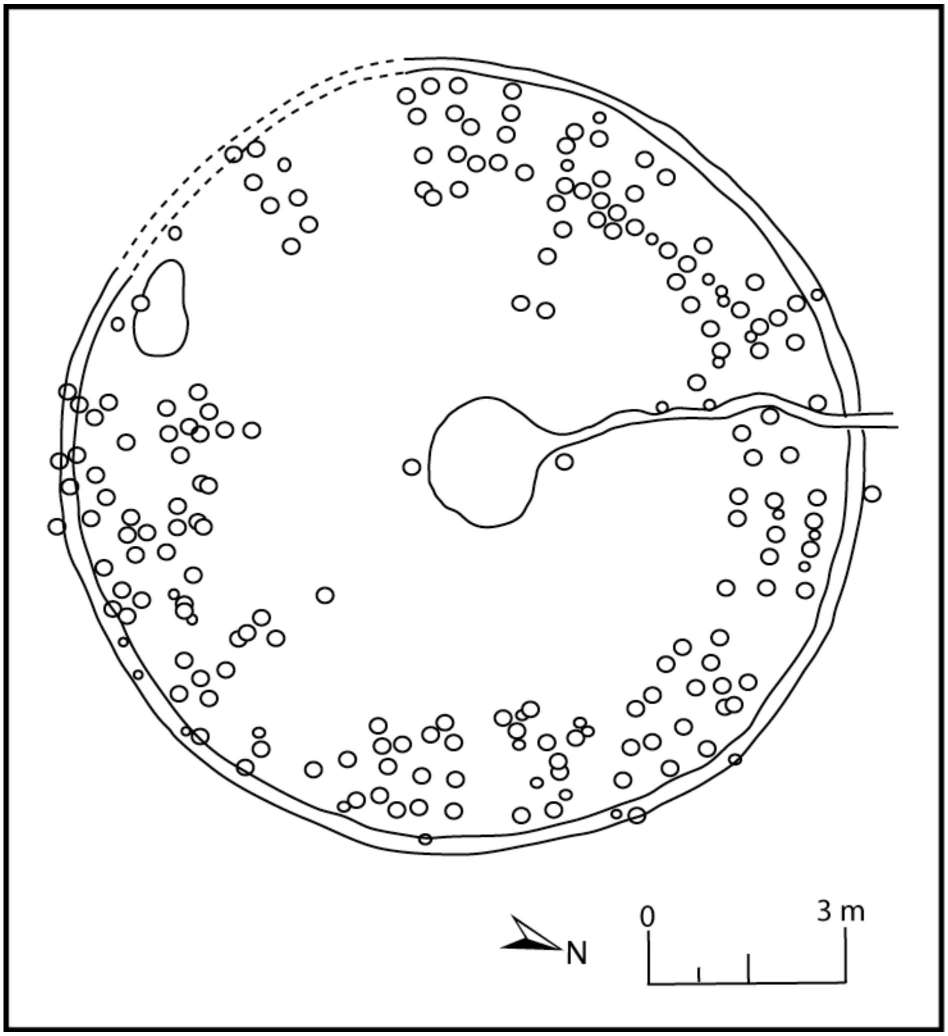

Figure 3.20 Circular Structure. After King 2003:65.

Geophysical Results and the Etowah Landscape

Etowah has long been known to archaeologists and the general public as an impressive place and important locality with respect to its place in landscapes of the Native American past. Despite Etowah's fame, there is a great deal of the site that has never been explored and therefore much about this ancient town that is not known. The objective of the geophysical survey investigations at Etowah has been to explore the usefulness of geophysical techniques for identifying buried archaeological deposits and old excavations across a broad archaeological landscape. Ultimately, the goal is to use non-destructive techniques to learn as much as possible about the distribution of features, structures, mound, and other kinds of cultural deposits on the site. The results discussed in Chapter 3 demonstrate the success of the archaeogeophysical investigations at Etowah in obtaining detailed archaeological information regarding the site's complex history.

ARCHAEOGEOPHYSICAL ARCHITECTURAL CHRONOLOGY

Given the possibilities of a binary architectural seriation based on the Type 1 and Type 2 structure magnetic anomalies, a series of maps are used to depict working models of the diachronic nature of changes in the Etowah landscape. At the present time there simply is not a sufficient amount of archaeological information to do more than divide the landscape into early and late periods. Following King's (2003a:51-83) chronology of the site, Etowah appears to have been settled and abandoned on several occasions. There is a considerable amount of archaeological consensus supporting the general three-tiered Etowah, Wilbanks, and Lamar phase sequence. The landscape models presented below do not challenge this chronological sequence but simply account for the observed variation in geophysical anomalies at the Etowah site.

In the following images all six of the mounds are left in place to provide additional landmarks for comparisons, but most importantly because any attempt to fit the mound construction sequence (King 2003a:61 and Figure 8) into a changing model of landscapes would take this analogy too far into the realm of speculation. As argued above there is an obvious architectural trend at Etowah from early wall-trenched houses to late non-wall trenched single post construction. The major unanswered question regarding the nature of the architecture and architectural history of the site is ironically limited to the Wilbanks phase, when it has been suggested that the majority of the mound construction events took place, followed by an abandonment of the site (King 2003a:88-91).

The distribution of the Type 1 (non-wall trenched houses) and Type 2 (wall trenched houses) geophysical anomalies are plotted in Figure 3.21. Figure 3.21 represents the possible organization of the early community at the Etowah site, with Type 2 structures, and Figure 3.22 represents a possible organization of the later community at the site, with Type 1 structures. These maps demonstrate a clear difference in the use and structural arrangements of the respective prehistoric communities. The earlier community appears to have placed a greater importance on internal organization, in that houses in the village are clearly arranged in a community plan with the use of well-defined plaza groups and more discrete neighborhoods.

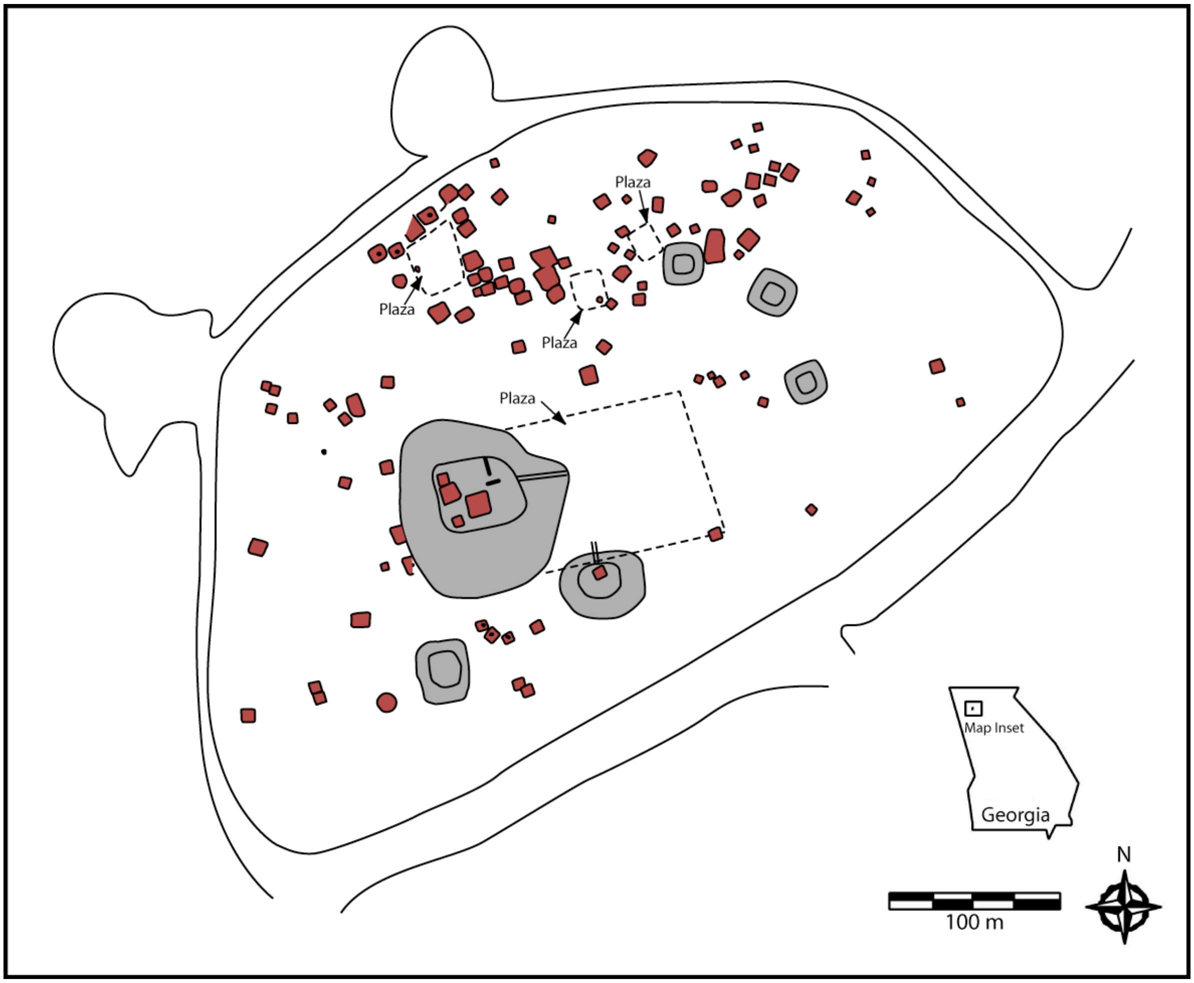

Figure 3.21 Community Organization of Early Etowah

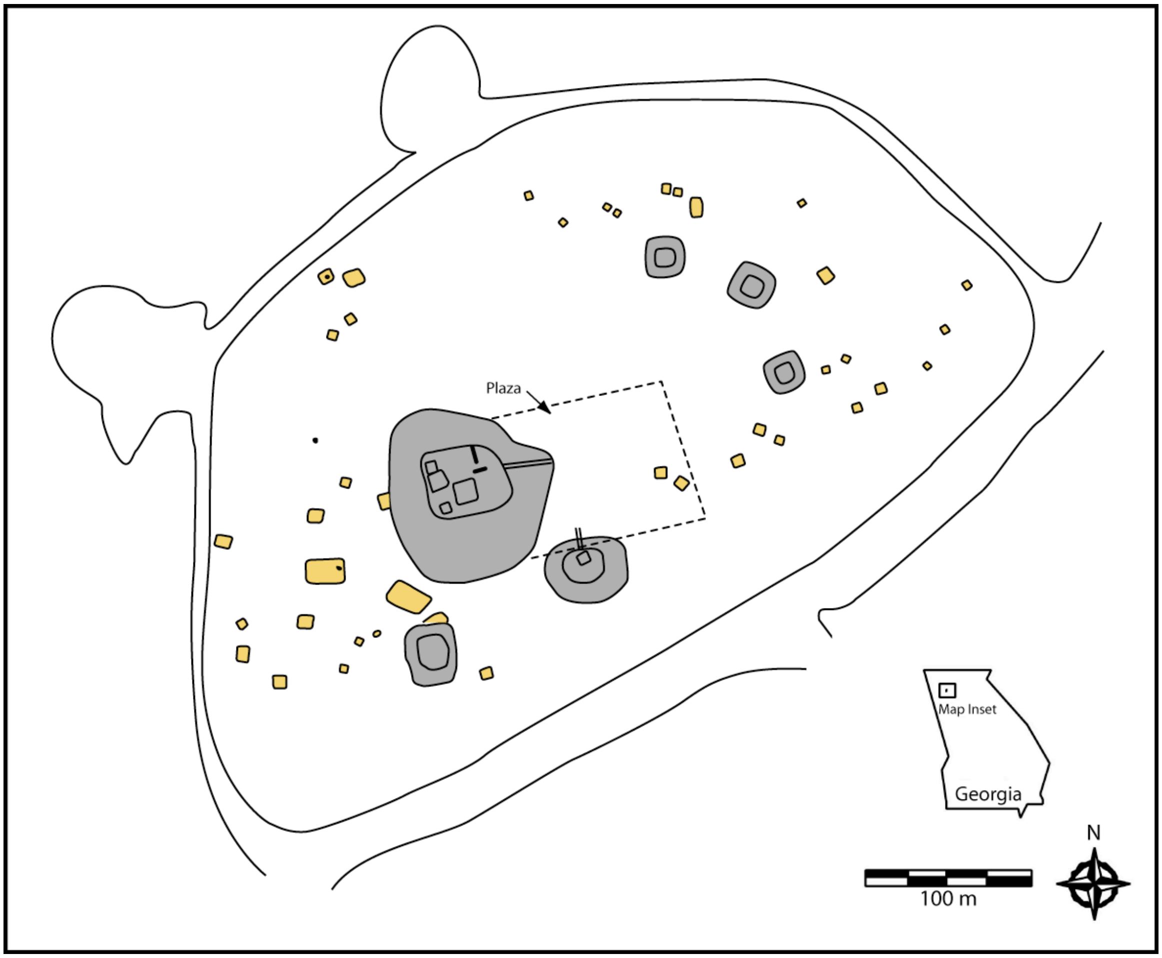

Figure 3.22 Community Organization of Late Etowah

The later community at Etowah (see Figure 3.22) shows less attention to an organizational community plan. Houses are much more dispersed across the site and do not seem to be arranged in any structural pattern concordant with Mississippian mound/plaza models of settlement organization. This admittedly may be partly due to the smaller number of Type 1 structures, which by itself suggests that the later community at Etowah was not as large and politically centralized as in earlier times, a fact that is indeed supported by other archaeological lines of evidence (King 2003a:92).

CORE PRECINCT

A core precinct existed at the Etowah site centered on the three main mounds A, B, and C as well as the summit top and surrounding architectural features and plazas (Figure 3.23). Based on various archaeological findings, the major mound construction sequences, and the geophysical interpretations proposed here, this elite precinct can probably be dated to the Wilbanks phase occupation of the site and was occupied or utilized by the ruling lineages of the Etowah community. The archaeogeophysical description of this elite precinct is complicated by the presence of several structures.

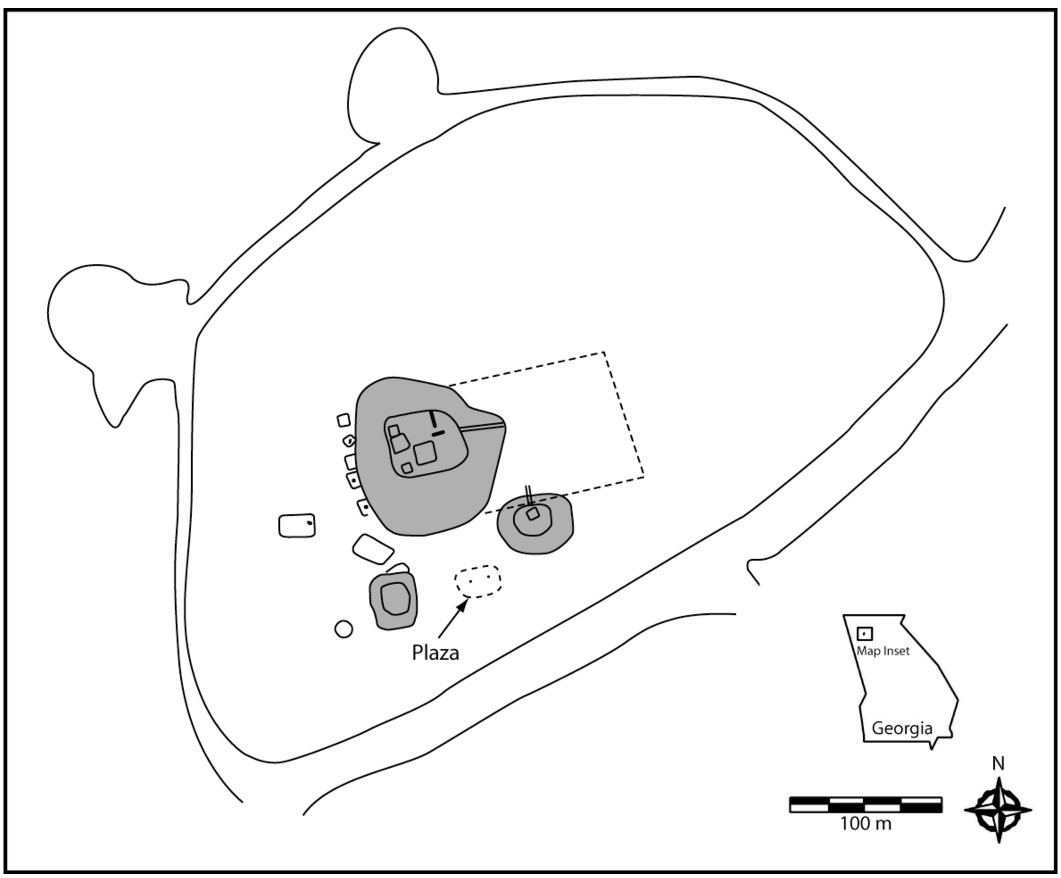

Figure 3.23 Elite Precinct at Etowah

PLAZA GROUPS

There are a few points to make regarding the five plazas present at Etowah (Figure 3.24). The three northern plazas—or village plazas—are defined by the arrangements of Type 2 anomalies and hence they are probably temporally affiliated with the earlier communities at Etowah. There are large positive magnetic anomalies along the outside perimeters of these plazas (Figure 3.12). The locations of these possible out door fire pits or hearths may be informative regarding the specific use of these communal spaces and the nature of the specific neighborhoods in which they occur.

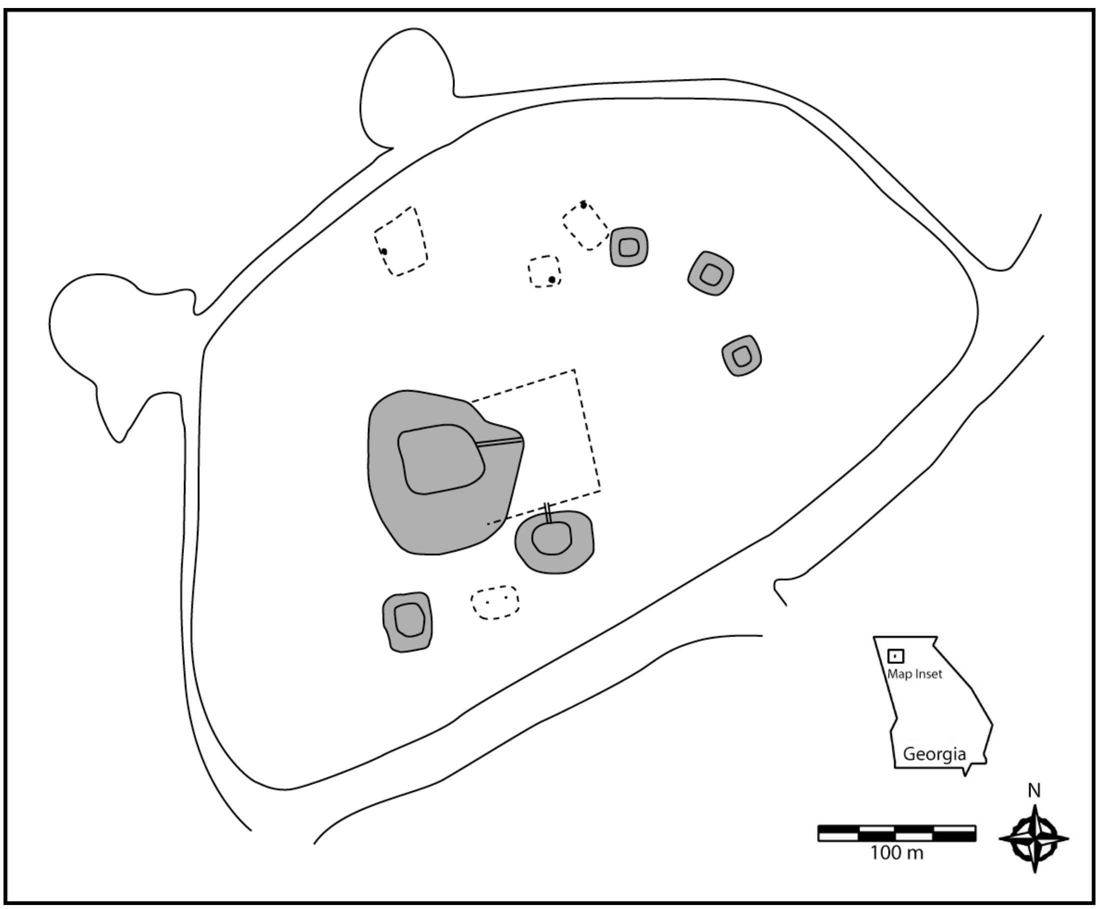

Figure 3.24 Distribution of Plazas at Etowah

The main Mound A plaza also leaves us with more geophysical questions than answers. As discussed above, at least a portion of this plaza was a prepared clay surface that capped early Etowah phase midden deposits. Combined with the archaeological data from the Mound A staircase excavations (King 1995) that argue for an early Wilbanks phase construction for the bulk of Mound A, a temporal affiliation of the Mound A plaza is difficult to establish with any certainty. The exact nature of the geophysical signature produced by the sediments in the Mound A plaza area suggests that a much smaller area was formally lined or prepared than what was previously believed. Given the uncertain link between the clay surface described by Sears and the complex geophysical trends noted at the foot of Mound A's front, additional geophysical exploration and excavations will need to be conducted to better understand the archaeological character of the Mound A plaza.

The presence of a plaza in the area between mounds B and C has been suggested by previous archaeologists (Sears 1958; Larson n.d.; King 1996). The ability to roughly plot the limits of this plaza is archaeologically significant, but not as compelling as the existence of two negative magnetic mono-polar anomalies located in the interior of this plaza (Figure 3.15). There are many possible sources for negative magnetic features. However, based on the remainder of the geophysical anomalies that are being interpreted as prehistoric archaeological features, some of the more obvious candidates can be readily eliminated. The negative magnetic features were most certainly not created by thermo-remnant magnetism from fire hearths or fire pits. Given their location in a plaza at the center of an elite precinct, a plausible explanation is that these two negative mono-polar anomalies are the filled-in pits of two large marker posts. Pole ceremonialism has a long and broad history across the entire prehistoric, protohistoric, and historic Native American Southeast (Hall 1997:102-108). If this supposition is correct, these poles would be further evidence that this area was used in public ceremonies (see King 2003a:61-83).

Conclusions

This chapter marks the first attempt to identify and define relevant archaeological information about the Etowah site from landscape-based archaeogeophysical survey. This information is the product of a mere 15 days of field work. The main point of the work at Etowah is the demonstration of the analytical power harnessed in the use of archaeogeophysical surveying when it is combined and contrasted with the findings from previous excavations at the site.

CHAPTER 4,

THE GEORGE C. DAVIS SITE

Introduction

I synthesize the findings of several magnetometer surveys conducted at the George C. Davis site (41CE19), an early Caddo site in East Texas. First I outline the archaeological and archaeogeophysical projects that have been conducted at the site, then analyze, interpret, and compare the magnetometer data to the kinds of archaeological features documented at the site through traditional archaeological excavations. Lastly, I discuss the spatial organization of the architectural features recorded by the magnetometer surveys as they relate to the overall community organization and layout.

George C. Davis Site

The George C. Davis site, on a large alluvial terrace of the Neches River, is one of the most well-known and extensively excavated sites in East Texas (Figure 4.1). Since the publication of the late 1930s-early 1940s Works Progress Administration (WPA)-University of Texas excavations at Davis (Newell and Krieger 1949), the site has loomed large in our understanding of the Early Caddo period (A.D. 1000 –1200) and framed much of what we know about Caddo cultural history in this part of the Caddo area, monumental architecture, ceramic technologies, and ritual interment of the dead (Newell and Krieger 1949; Spock

1977; Story 1972, 1981, 1998).

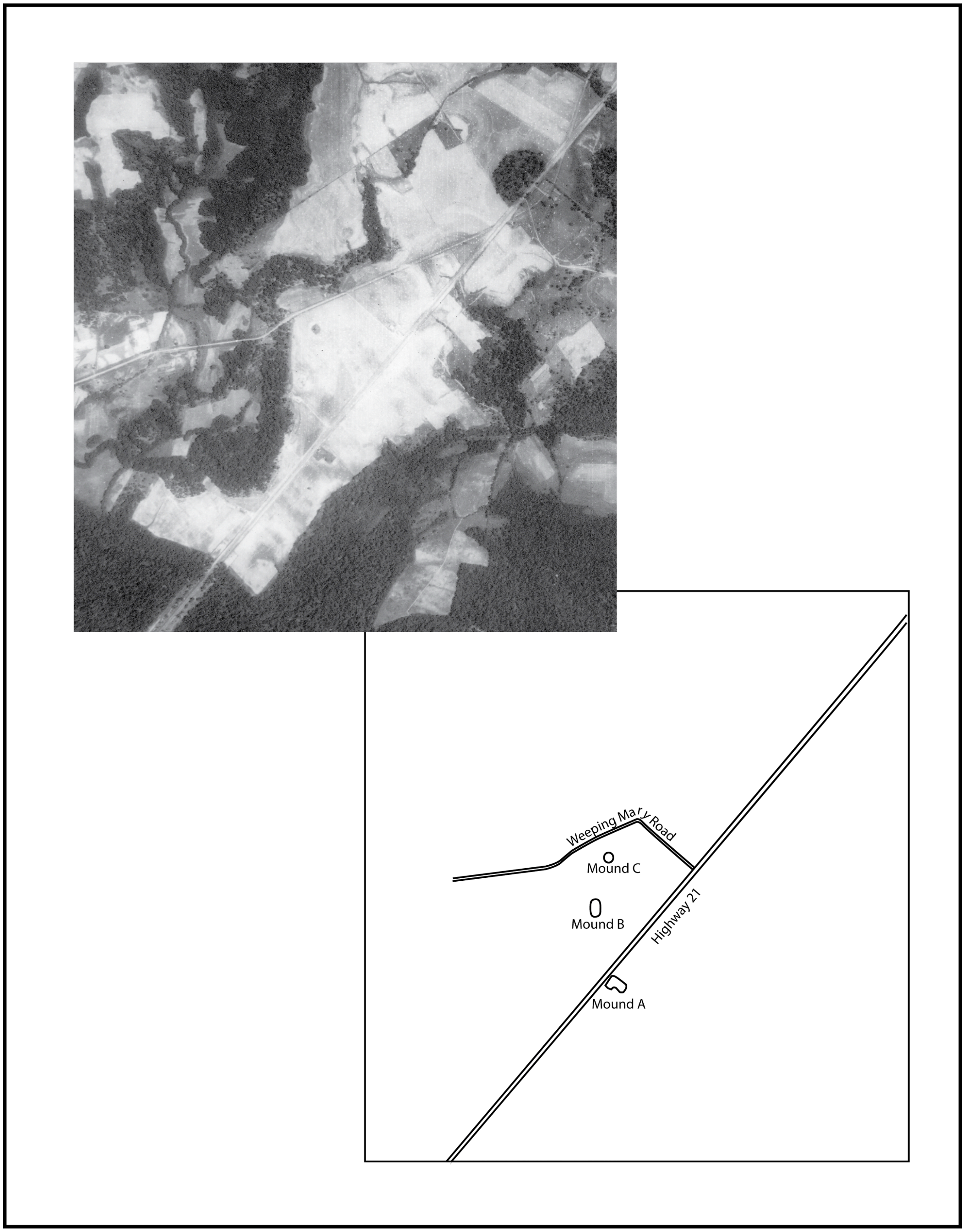

Figure 4.1 The George C. Davis Site (41CE19).

The majority of the intensive investigations at Davis have focused on the three mounds (Mounds A-C; Mounds A and B are platform mounds, while Mound C is a accretional burial mound) and their adjacent architectural features. Archaeological excavations have documented some 51 structures, both domestic and ritual, at George C. Davis (Spock 1977; Story 1998:26). More recently the George C. Davis site has proven to be an ideal test ground for evaluating the utility of archaeogeophysical techniques on Caddo mound centers. The Texas Archeological Research Laboratory (TARL) at The University of Texas as well as the Texas Historical Commission (THC) have located many more Caddo structures and have added a great amount of information regarding the intra-site arrangements and architectural detail of structures (Bruseth and Pierson 2004; Creel et al. 2005; Creel et al. 2008; Osburn et al. 2008).

Archaeological Research at the George C. Davis site

The George C. Davis site has been instrumental in the development of Texas archaeology, especially the archaeology of the Caddo Indian peoples that lived in East Texas. J. E. Pearce, of the University of Texas and with funding from the Bureau of American Ethnology, first recorded the site in September 1919. In August 1933, E. B. Sayles of the Gila Pueblo survey conducted an uncontrolled surface collection at Davis, which constituted the first field work at the site by a professional archaeologist. The site was given the field designation II:8:1 (Story 1981).

The first extensive excavations at George C. Davis were conducted from November 1939 to September 1941 by a joint project with the University of Texas at Austin and the WPA. H. Perry Newell was the Principal Investigator and oversaw the excavations (a total of 7000 m^2), including approximately 60% of

Mound A and 100 m^2 of the village area to the southeast of mound A (Newell and Krieger 1949). With Newell's death in 1946, Krieger's preparation of the now classic final report rightly contributed to the importance of the George C. Davis site. Since its publication, the report has become just as much of an icon of Texas archaeology as the site itself (Story 1998, 2000). Krieger advanced a chronology of the Caddo region based in part on Newell's meticulous excavations at George C. Davis. This chronology was corrected after the advent of radiometric dating (Story 1998:12); however, its general structure has largely stood the test of time, with the exception of the fact that George C. Davis is not as old as Krieger would have it (i.e., contemporaneous with Hopewellian and Marksville cultures), but is nevertheless a very early Caddo site that was first occupied around ca. A.D. 850 (see Story 1998, 2000).

Dee Ann Story conducted a University of Texas field school at the site during the summers of 1968 and 1970 with support from the National Science Foundation (GS-2573 and GS-3200), the Texas Building Commission, and the Texas Historical Survey Committee [IAC (70-71)-258 and IAC (70-71)-485] (Story 1997). Story's field school excavations were all within what is now the Caddoan Mounds State Historic Site, which is across Highway 21 from Mound A. Story excavated portions of Mound B (15% or 451 m^2) and Mound C (32% or 333 m^2), areas in between the mounds in the village (2,515 m^2), and tested the one known borrow pit (67 m^2) off the terrace edge (Story 1972; Arnold 1973; Shafer 1972; Keller 1974; Fritz 1975; Spock 1977; Story and Valastro 1977; Story 1981).

Story conducted investigations at George C. Davis again between September and November 1977 as part of an Interagency Cooperative Contract [IAC (78-79)-0499] between the Texas Parks and Wildlife Department and TARL.

The 1977 field project (Fields 1978) was focused in occupation areas to the east of Mounds B and C. Another project was conducted via an interagency Cooperative Contract [IAC (78-79)-1849] between the Texas Parks and Wildlife Department and TARL (Thurmond and Kleinschmidt 1979) in the fall and winter of 1978. Excavations were conducted at the area directly adjacent to Highway 21 to make way for the construction of the Caddoan Mounds State Park facilities.

In the summer of 1978 Ed Baxter of Texas A&M University served as Principal Investigator on a contract project with the Texas Forest Service. Darrell Creel, a former student of Story, directed the field excavations for this project (Creel 1979). The Texas A&M University excavations were conducted on Texas Forest Service property north of the Caddoan Mounds State Park across Weeping Mary Road (Figure 4.2). Elton R. Prewitt of Prewitt and Associates served as Principal Investigator on a contract with the Texas Forest Service in the spring of 1980 (Fields and Thurmond 1980). Further excavations were conducted on Texass Forest Service property north of Weeping Mary road. Figures 4.2 depicts the distribution of all the archaeological excavation units completed at the Davis site up to the time of the 2003 TARL excavations, while all the structures recorded at the site through 1977 is shown on Figure 4.3

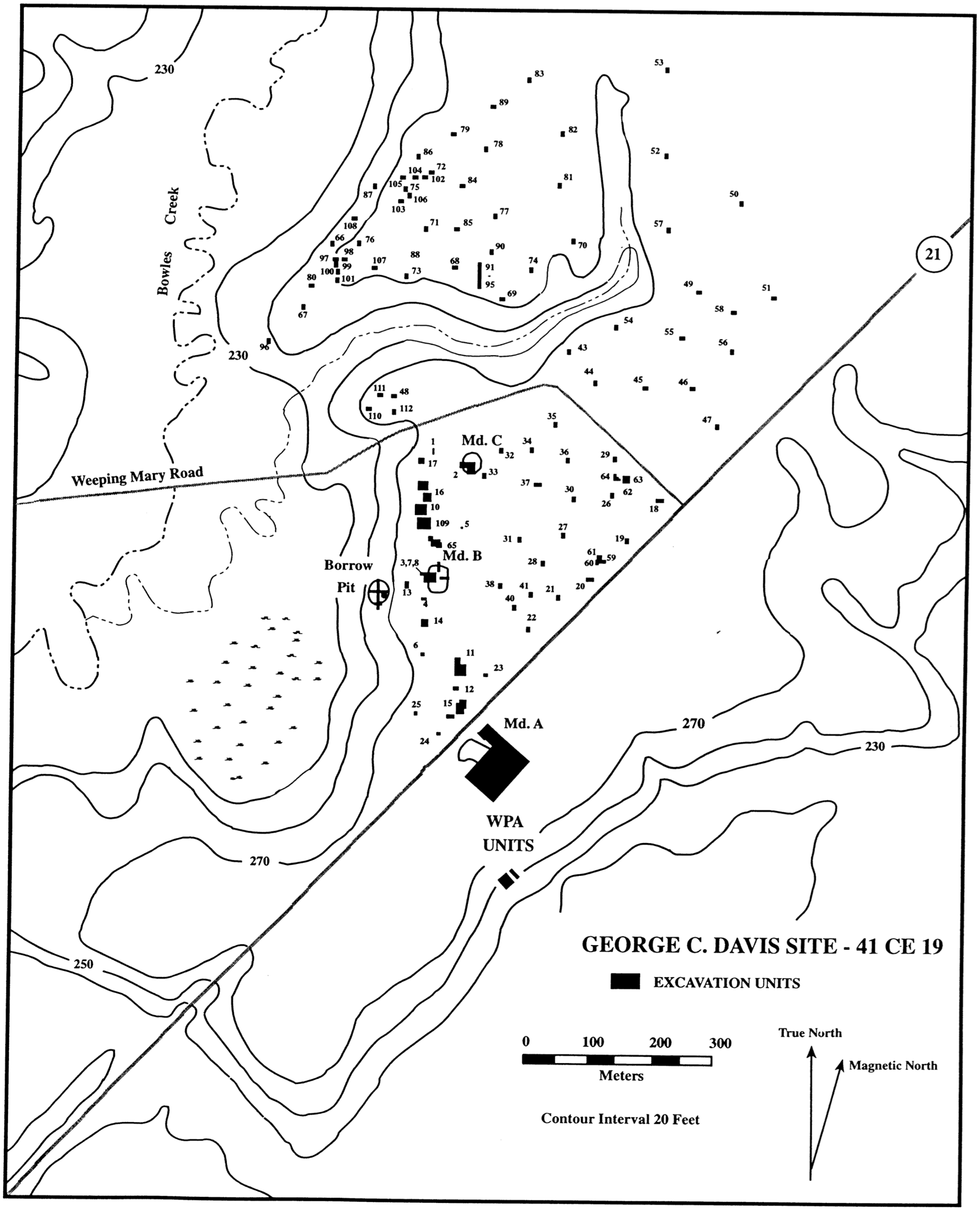

Figure 4.2 Locations of Excavation Units at The George C. Davis Site. After Story 1998:2.

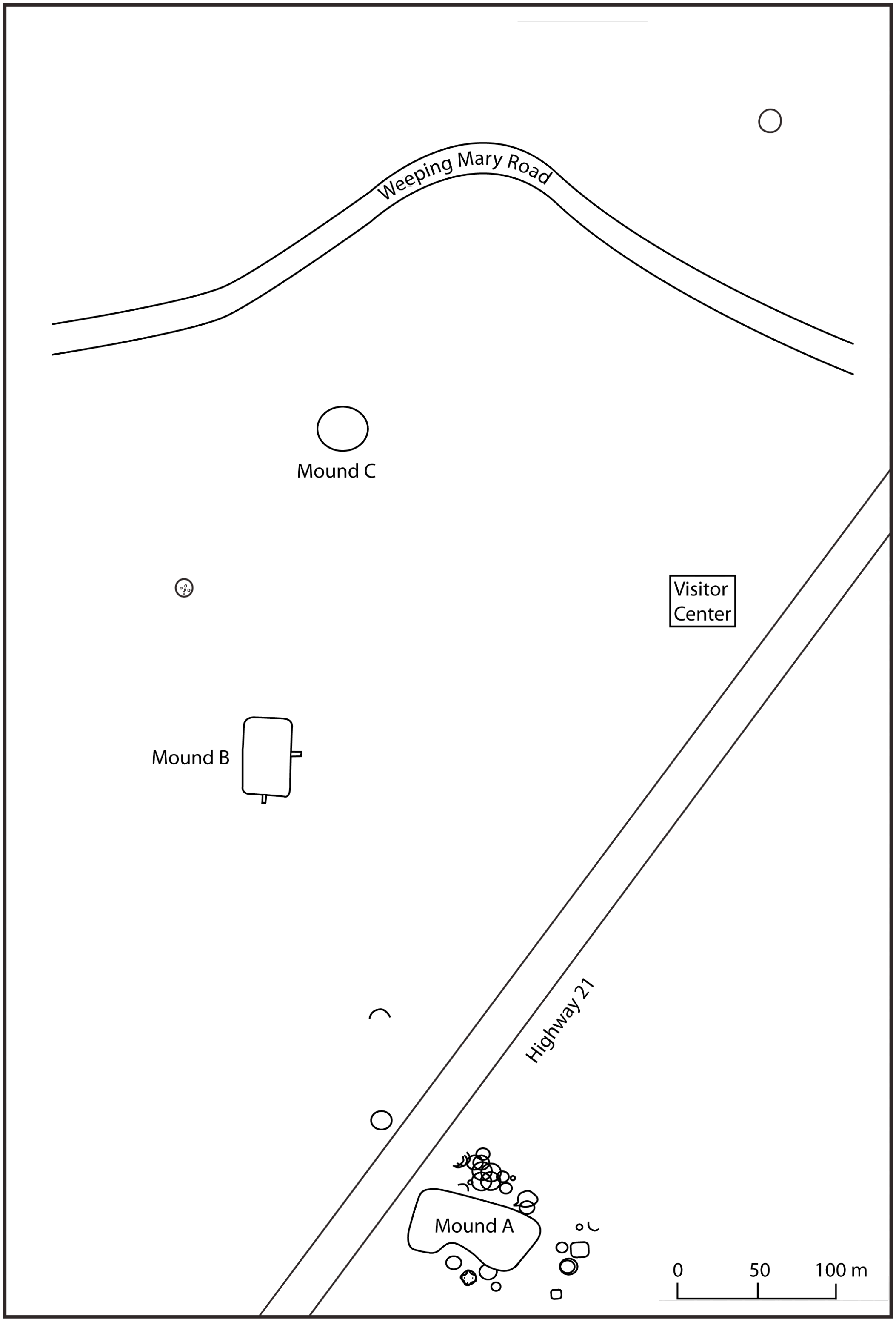

Figure 4.3 Locations of structures located at the George C. Davis site through excavation.

Archaeogeophysical Investigations at the George C. Davis site

Story (personal communication, 2003) was the first to use archaeogeophysics at the George C. Davis site in the early 1970s. This was also one of the first uses of archaeogeophysics in Caddo archaeology in general (Walker and Perttula 2008:159). Electromagnetic Induction (EM) was employed in the area directly adjacent to Mound B, however, unfortunately, the data was never fully processed, analyzed, or published. In 2002, TARL commissioned a ground penetrating radar (GPR) and magnetometer survey of portions of this site to explore for features Creel had noted in earlier excavations (Creel et al 2008:177). The magnetometer survey, conducted by the THC, was successful in locating several Caddo structures (Bruseth and Pierson 2004). This work was also instrumental in helping to start what has been referred to as a "Revolution in Caddo Archaeology" (Perttula et al. 2008) by ushering in the widespread use of geophysical techniques in East Texas Caddo archaeology. Darrell Creel and Samuel Wilson of The University of Texas and TARL extended the magnetometer survey in 2003-2004 to cover the full extent of the property then owned by the Texas Parks and Wildlife Department, as well as a small portion of private land to the south of the park (Creel et al. 2004; Creel et al. 2008) (Figure 4.4).

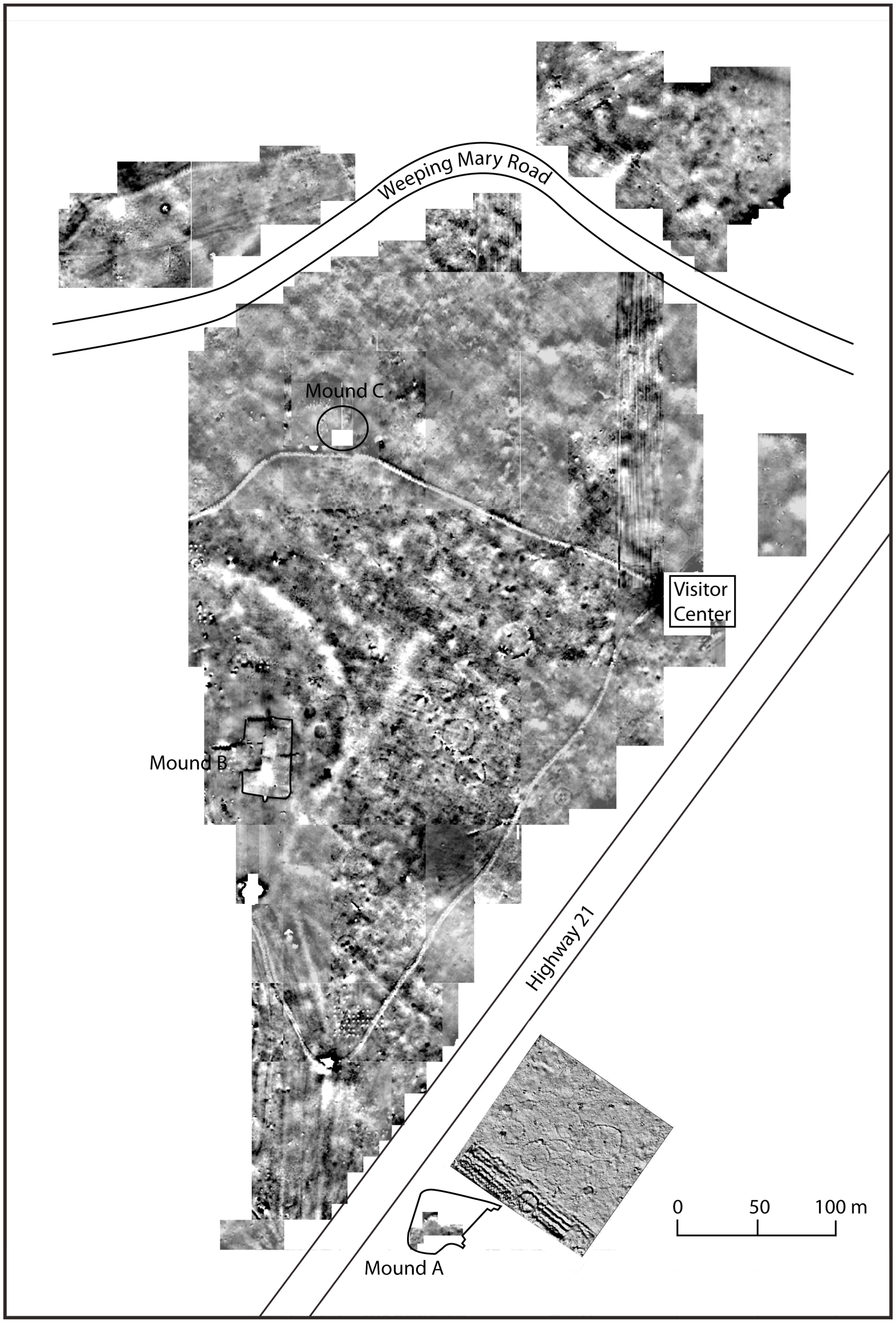

Figure 4.3 Locations of structures located at the George C. Davis site through excavation.

In 2008 the THC took control of the state-owned portion of the George C. Davis site at Caddoan Mounds State Park, and through the help of multiple parties was able to gain access to portions of the site east of Highway 21 on Texas Forest Service. To date the THC has surveyed a small portion (1 ha) of this tract (which is approximately 30 ha in size) (see Figure 4.4), and this work has located several structures in the area directly adjacent to Mound A (Osburn et al. 2008).

Field Methods and Data Processing

A Geometrics G858 portable cesium magnetometer was used during the TARL archaeogeophysical survey with the two sensors spaced 50 cm apart in a total field configuration mounted on a hand-pulled cart. The magnetometer sensors were pulled along the survey line, allowing for each sensor to extend 25 cm on either side of the traverse line. Survey lines were spaced at 1 m intervals with data collected on a 0.1 second interval; surveyor pacing was adjusted to collect approximately 10 readings per m. A Geometrics G-856 proton magnetometer base station was used off site to collect data at 10 second intervals in order to record the observed diurnal variation.

The data were downloaded using MagMap 2000. With MagMap 2000, the base station diurnal correction was applied to the files, and grid coordinates were assigned to each collection block. The magnetometer data were imported into ArcGIS 9.2 and gridded, then presented for visual display.

Survey Results

The geophysical interpretations of the George C. Davis site presented here represent a group effort. The TARL project on the portions of the site to the west of Highway 21 were first published in 2004 (Creel et al. 2004) and have been updated by Schultz (2009), Creel (Creel et al. 2008), as well as the author. The THC data collected west of Highway 21 was first published in 2003 (Bruseth and Pierson 2004) and later in 2007 (Bruseth et al 2007). The THC geophysical data obtained from that portion of the site east of Highway 21 was published in 2008 (Osburn et al. 2008).

Criteria Used in Interpretation

Before any archaeological interpretations are presented, the non-archaeological information obtained from the geophysical survey is reviewed. These are geophysical signatures not related to the prehistoric archaeological landscape and are grouped into two major categories: Geological Trends and Non-Archaeological or Geological Trends. Geological trends in the geophysical data are the product of natural geological or geomorphological processes on this Neches River terrace, while the non-archaeological or non-geological trends includes natural phenomena (such as lightning strikes that leave a distinguishable geophysical signature (Jones and Maki 2004) as well as modern cultural activities.

The criteria used for the archaeological interpretations of the George C. Davis data are based on information from previous excavations (Newell and Krieger 1949; Spock 1977; Story 1972, 1981, 1998), limited ground truthing excavations conducted on four of the geophysical features (Wilson and Schultz 2009), as well as comparisons to other geophysical data sets (see Chapters 3 and 5). The geophysical analysis closely follows the known forms of architecture that are present at the Davis site as well as other Caddo sites. The interpretations are at the level of the architectural feature: i.e., the structure, house, or building. In some cases more specific interpretive analysis can be made of geophysical anomalies within structures; however, these should be viewed as possible interpretations that would require further excavations to fully resolve. In general, the interpretations presented here are conservative. Future geophysical interpretations, combined with limited archaeological information—as was discussed in Chapter 3–would increase the breadth of, and confidence in, the archaeological interpretation of the magnetometer data.

The majority of the anomalies interpreted as archaeological features at the George C. Davis site have not been ground truthed. There is, however, enough contrast between the geophysical signatures of archaeological features and the background geophysical data from the site as a whole to permit interpretation of the sorts of familiar patterns (i.e., structures) known from previous archaeological investigations. The exceptional legibility of the magnetometer data has allowed for the direct correlation between the geophysical analysis and what the geophysical signatures represent in terms of archaeological information. The geophysical anomalies interpreted as representing archaeological features are referred to as <u>geophysical features</u>. The geophysical features that relate to architectural features are divided into four categories: Button Houses, Circular Houses, Sub-Round Houses, and Hearths (Creel et al. 2008:185-186; Osburn et al. 2008:196 and Table 1). Other archaeological features, such as possible burials and historic trails, are also discussed in more detail below.

Geological Trends

Perhaps the most striking feature of the magnetometer data is the almost total absence of overbearing geological trends obscuring the signatures from the prehistoric archaeological deposits. The geological situation at Davis appears to be perfect for the recovery of negative relief features due to the magnetically enhanced subsoil, and the fact that cultural features at the site are filled with less magnetic cultural fill (Bruseth et al. 2007:137). Perhaps the most important geological trend in the magnetometer data from the Davis site is not a trend that is visible in the data, but what is not present in the geophysical data. As Story notes (1997:3), the Davis site occupies a high Pleistocene terrace with little to no recent deposition. Years of plowing has scraped away much of the upper portions of the site leaving only the bottoms of pits, post holes/molds, and hearths preserved in the archaeological deposits (Story 2000:6)

Non-Archaeological or Geological Anomalies

There is a surprisingly low level of geophysical noise in the data resulting from modern cultural activity, particularly when considering the amount of intensive agricultural activity that has been conducted on the site: especially on that part of the site east of Highway 21 (Figure 4.5). Plow furrows are visible in the data from both sides of the highway; however, given that the geophysical data east of the highway was collected at a time when the area was freshly plowed, a more visible and higher contrast pattern is apparent there (Osburn et al

2008:194).

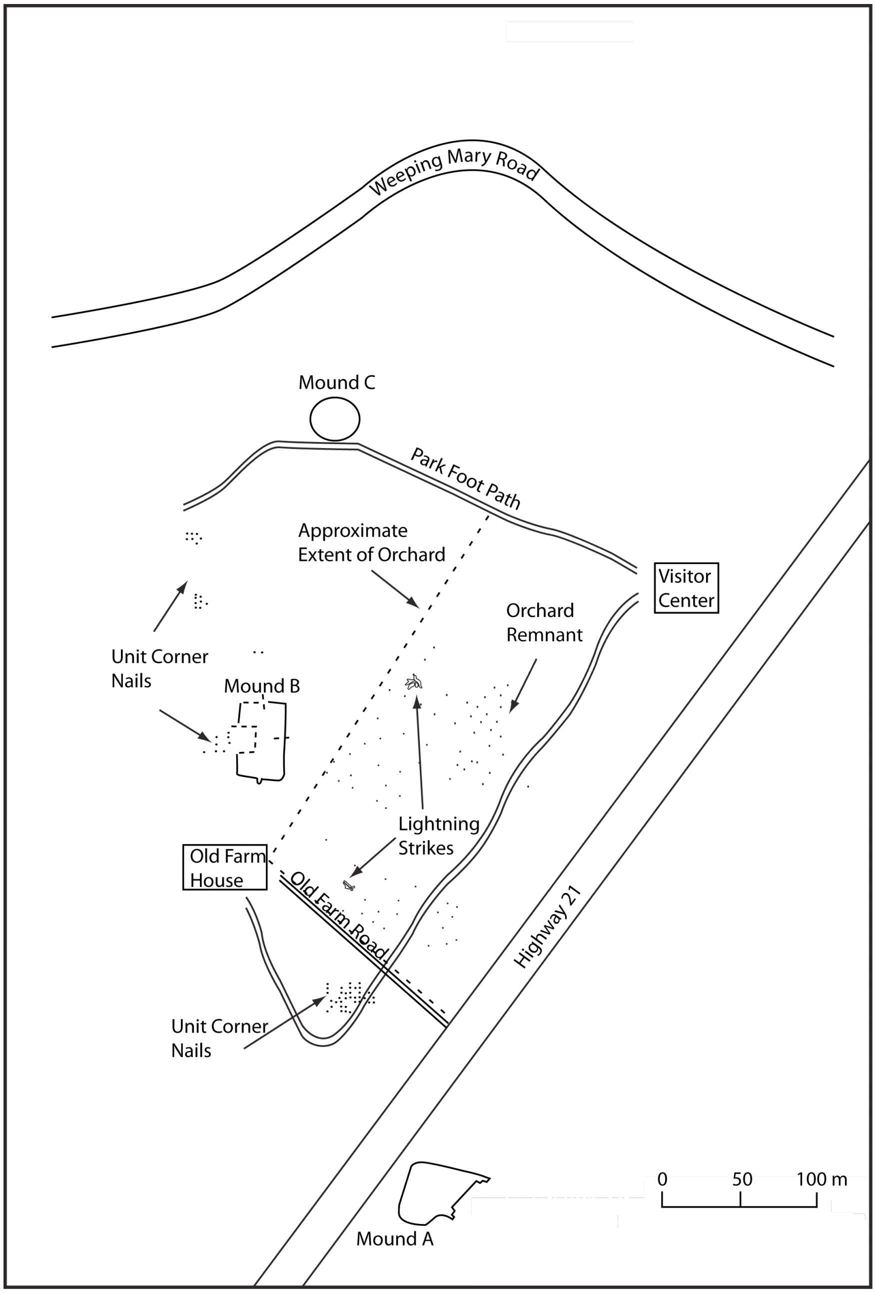

Figure 4.5 Locations of anomalies caused by recent activity.

The most obvious modern cultural anomaly in the magnetometer data west of the highway is the crushed gravel footpath that encircles the Caddoan Mounds State Park. This path starts at the park's visitors center and extends west to the base of Mound C (see Figure 4.4), turns south and passes to the east of Mound B, then continues on to the southern portion of the park boundaries before looping back to the visitors center.

Several dipolar anomalies are arranged in a series of square patterns (see Figure 4.5). These are steel spikes that were used to mark the corners of Story's village excavations.

There are a few possible lightning strike features present at the site (see Figure 4.5). Jones and Maki (2004:191-197) have clearly demonstrated the unique patterning associated with lightning-induced remnant features (LIRF) such as the two shown in Figure 4.6. According to Jones and Maki (2004:191), LIRF anomalies either occur as radial or linear patterns, both of which are present here.

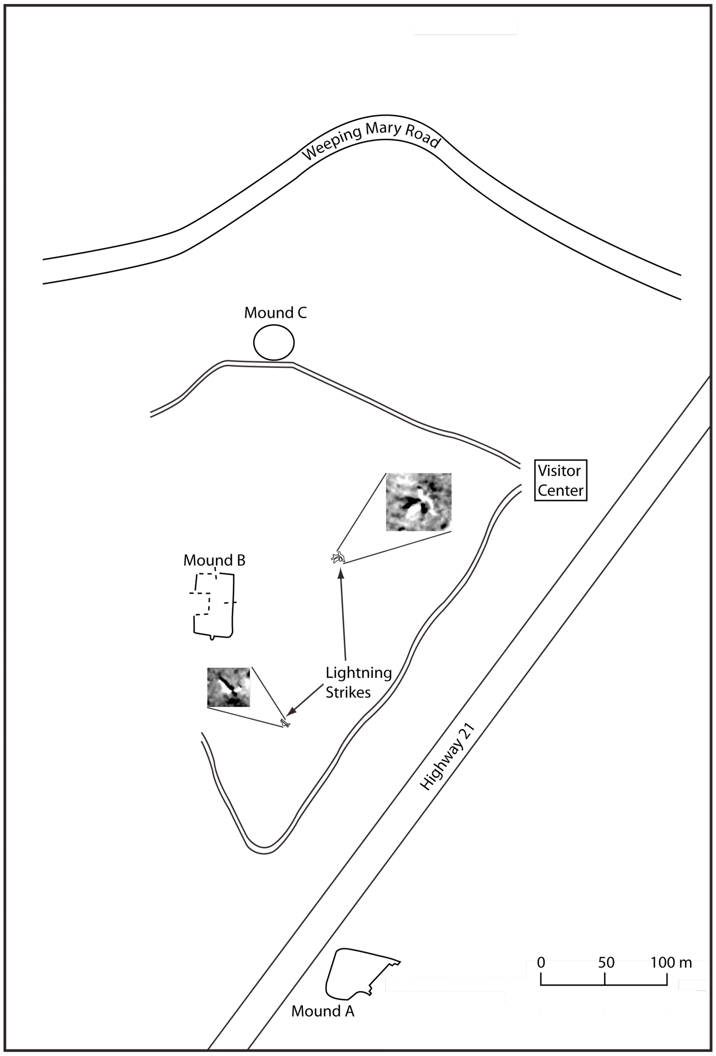

Figure 4.6 Locations anomalies caused by lightning strikes.

Types of Archaeological Features

There is a considerable amount of variation within the general sub-round to circular house forms across the Caddo region that is echoed in both the excavated and archaeogeophysically-defined houses from the Davis site (for a recent analysis of Caddo architecture, see Schultz [2009]; see Spock [1977] for earlier analysis of the architecture from George C. Davis). There are, however, a few large[2] (> 20 m in diameter) circular anomalies present in the geophysical data from Davis that are large enough to suggest the possibility of them representing something other than structures, possibly some sort of outside enclosure (Creel et al. 2008:188).

The overall distribution of geophysical features is strongly biased towards that portion of the site to the northwest of Highway 21. Certainly many more features than those detected by Osburn et al. (2008) will be present on the southeast side of the highway if and when that area is finally surveyed. Currently there is a greater concentration of geophysical features of an architectural nature in the area directly east of Mound B (Figure 4.7), with an additional concentration north of Mound A. These architectural features are divided into three types of structures; Type 1, 2 and 3, as well as Hearths (Figure 4.8).

[2] An important caveat must be made regarding the use of exact measurements made from geophysical features. These measurements should all be considered approximations of size, as they are not actual measurements of the structure – but measurements of the structure's magnetic signature.

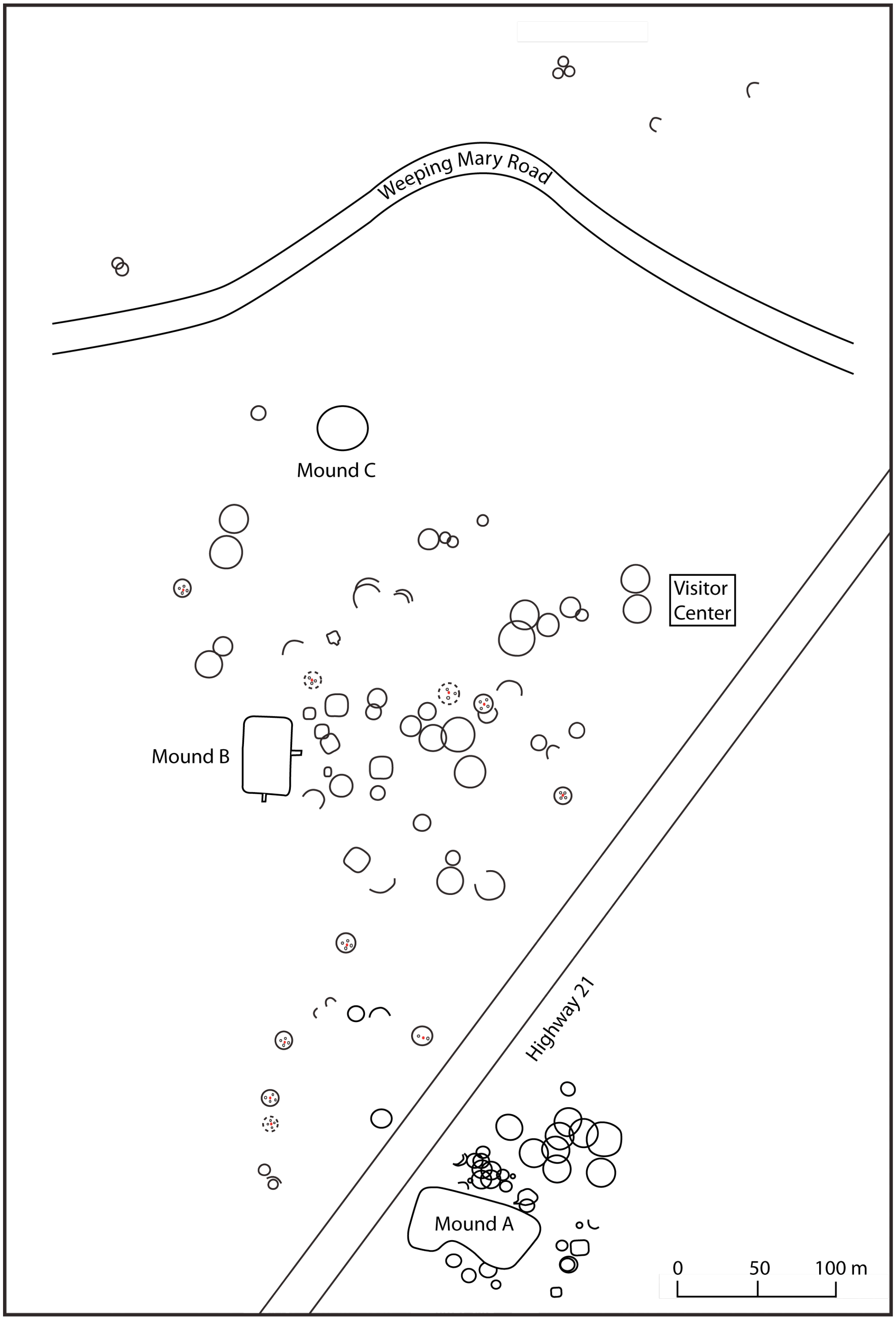

Figure 4.7 Locations of structures located at the George C. Davis using geophysics.

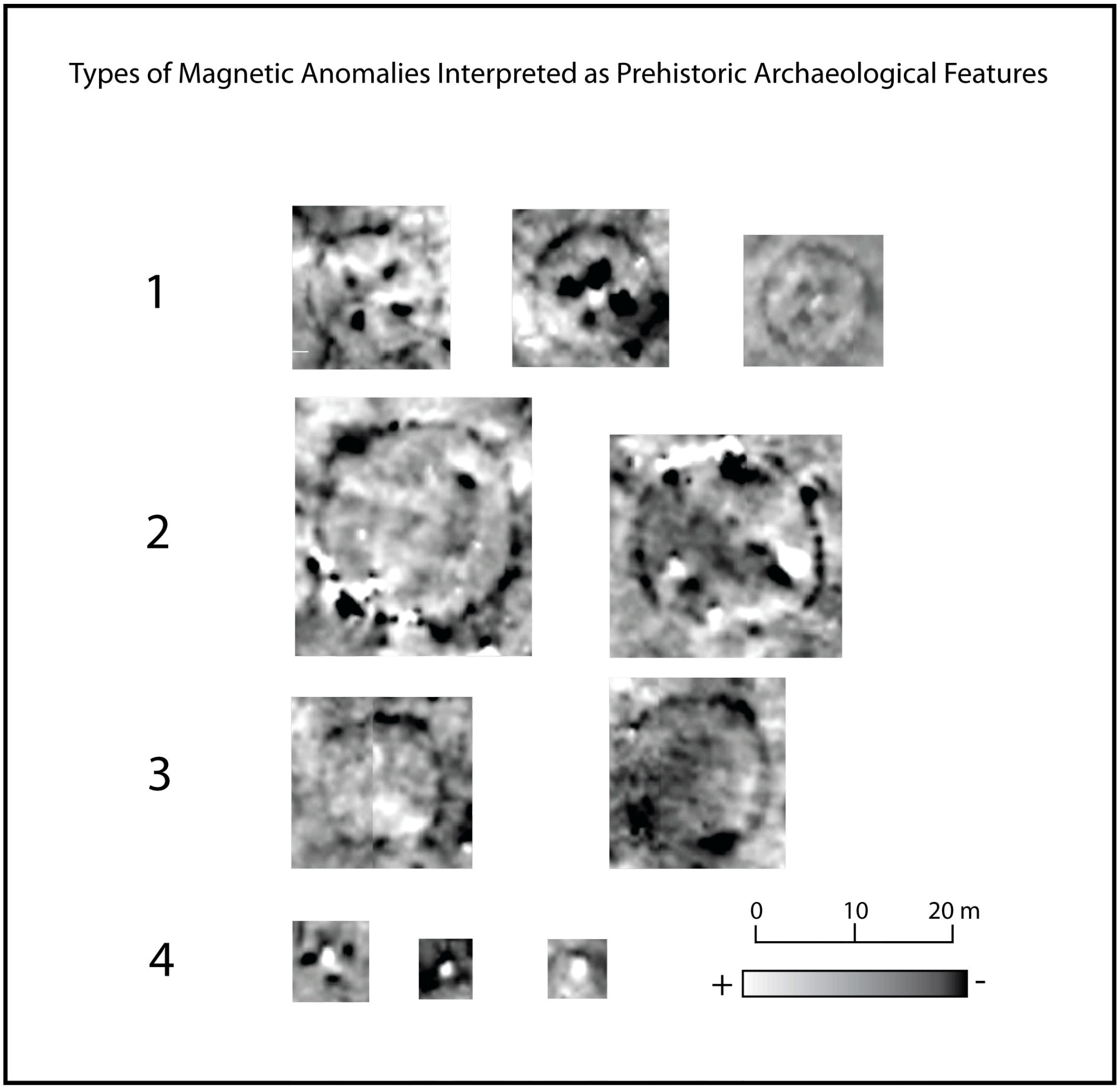

Figure 4.8 Various types of geophysical signatures interpreted as architectural.

Type 1 Houses

One of the most striking architectural forms identified in the magnetometer data from Davis are referred to here as "Type 1 Houses". These structures have been jokingly referred to as "Button Houses" due to their superficial button like appearance. Type 1 houses range in size from approximately 10-15 m in diameter (Figure 4.8-1). The hallmarks of the Type 1 House are four low magnetic circular returns arranged in a square-like pattern with a single circular high or dipolar anomaly in the center. This grouping of anomalies no doubt represent four large interior pits or post mold/hole features surrounding a central fire hearth. Several of the button houses recorded in the geophysical survey are located to the east of Mound B intermixed within the dense cluster of other structures in that area (Figure 4.9; see also Figure 4.7). There is also a second concentration of Type 1 Houses located in the southern portion of the site northwest of Mound A, which is an area that otherwise seems to have been much less intensely occupied.

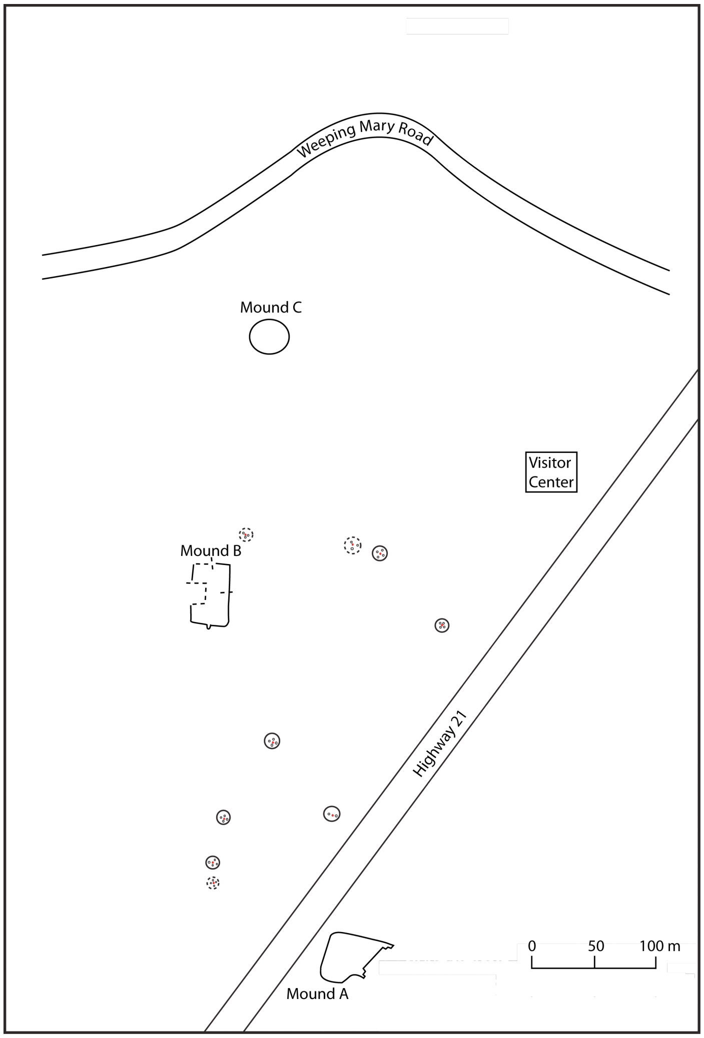

Figure 4.9 Distributions of Type 1 Houses.

Feature 42 beneath Mound A is an unequivocal archaeological and architectural match to the button houses identified in the magnetic data. The partially excavated structure was in the south central corner of Mound A approximately 4.94 m below the Mound A datum (Spock 1977:89; Newell and Krieger 1949:44). The structure had 51 exterior and 45 interior post mold features and four interior pit features. These pit features were all oval in shape, filled with a disturbed reddish matrix, and contained a small amount of ceramic debris.

Spock (1977:92) also noted a Gahagan biface as being associated with Feature 42 as well as “other artifacts” located 0.43 to 2.74 m above the floor of Feature 42. Unfortunately no datable organic materials were recovered from any of the four interior pits of Feature 42.

Feature 31, also from Newell’s Mound A excavations, appears to also fit the button house form, although it is not as clear a match as Feature 42. Like Feature 42, Feature 31 was located in the southwest corner of Mound A approximately 4.64 m below the Mound A datum (Spock 1977:59; Newell and Krieger 1949:Figure 15). Feature 31 is superimposed on two earlier structures (Features 37 and 38), is made up by 78 exterior and 31 interior posts features, and measures approximately 14.9 m in diameter (Spock 1977:59). The four internal pits (F31-3 through F31-6) were arranged in a similar pattern as the interior pits from Feature 42 as well as the type 1 houses identified in the geophysical data.

In addition to these four interior pits, Feature 31 had a central hearth (F31-1) that was round and basin-shaped and 4.8 m below the Mound A datum. The hearth contained a burned sandy clay fill that “when first exposed appeared as an area of bright burned red and black soil on the floor” (Spock 1977:62). A prepared lining of burned clay covered the hearth with the exception of a center post hole.

Figure 4.10 is a side-by-side comparison of Featuress 31, 42 and 125. Features 31 and 42 were excavated by Newell and were both with in the extent of Mound A. Feature 125 was excavated by Story just north of Mound B. There is great consistency in the shape and internal architectural characteristics of these features. It is possible that the four interior pits from Feature 242 are actually similar in shape and size to those of both Features 237 and 125. Comparing the two geophysical features, the differences may be related to differences in size; to differences in the dynamic range of the magnetic values for these features; as well as variation in the distributions of color over the images data points. These two images were gained differently in order to increase their legibility.

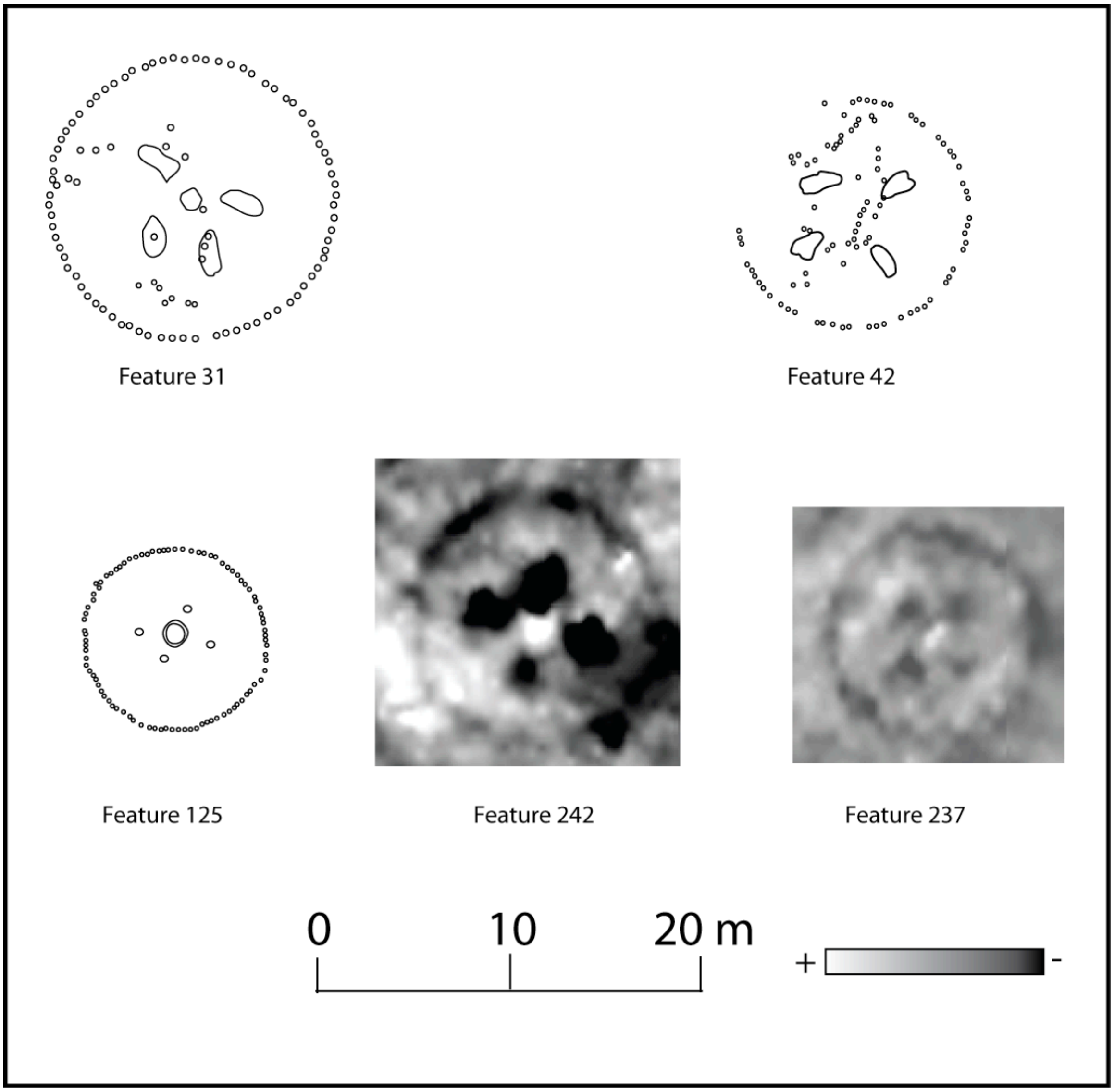

Figure 4.10 Comparisons of Type 1 Houses to excavated structures.

Type 2 Houses

There are several clearly definable low magnetic circular anomalies at the Davis site that measure between 5 and 20 in diameter (see Figure 4.8-2). These circular anomalies, or in some cases partial arcs, can be readily linked to the well known circular Caddo architectural style of house construction (see Schultz 2009). A negative relief feature with a fill that has a lower magnetic signature than the surrounding clay subsoil creates these anomalies. If these anomaly types do actually represent Caddo houses, several of them (n=4 Features 238, 265, 255 and Osbourn et al 2008:196 Table 1 feature 2) would represent some of the largest known Caddo structures to date, being up to 20 m in diameter.

Type 2 houses are the most evenly distributed architectural form at the Davis site (Figure 4.11). In the portion of the site northwest of Highway 21, circular structures, as well as partial arcs that are probably partial signatures from additional circular structures, are concentrated in the area east and southeast of Mound B as well as the area between Mounds B and C. Southeast of the highway, there is also a concentrated area of type 2 structures.

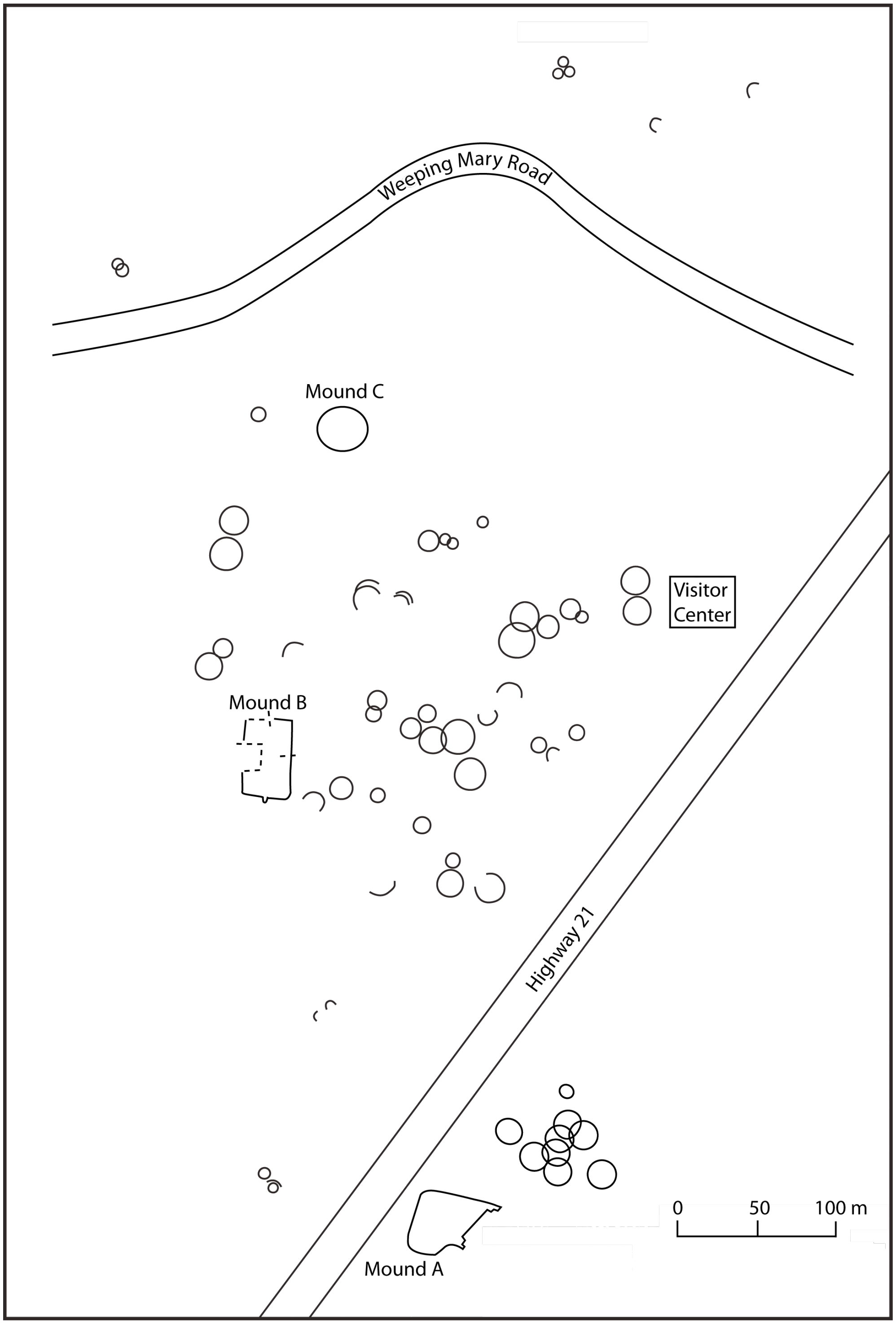

Figure 4.11 Distributions of Type 2 Structures.

There are many circular structures at the Davis site to use for comparison to the structures detected in the geophysical survey. Circular structures comprise the majority of the structures found at the site in the excavations. According to Spock (1977:30), there are 34 circular structures or 66% of the total number of excavated structures. There are 47 circular structures and 15 arcs or partial circular structures are present in the magnetometer data set (as of summer 2008); this is 81% (n=77) of the current total of geophysical features. Feature 146, excavated in Story's Unit 15, is a good example of a round structure. Unit 15 was located to the northwest of Mound A to the west of Highway 21. Structure 146 was 10.8 m in diameter and comprised of 85 posts with a 1 m wide entrance opening to the northeast with no prepared or definable floor (Story 1997:92). In general, Story (1997:91) noted an increase in artifact densities as well as an increase in exotic materials in the structure's archaeological deposits.

Type 3 Houses

Type 3 houses are simply circular type anomalies with truncated or rounded corners (Figure 4.8-3). This structure type is well represented in the excavations from the Davis site (Spock 1977:30), and a few are present in the geophysical data set (n=8). Sub-Round structures are largely clustered just to the east of Mound B (Figure 4.12). Two sub-round geophysical features are located in the cluster of structures north of Mound A.

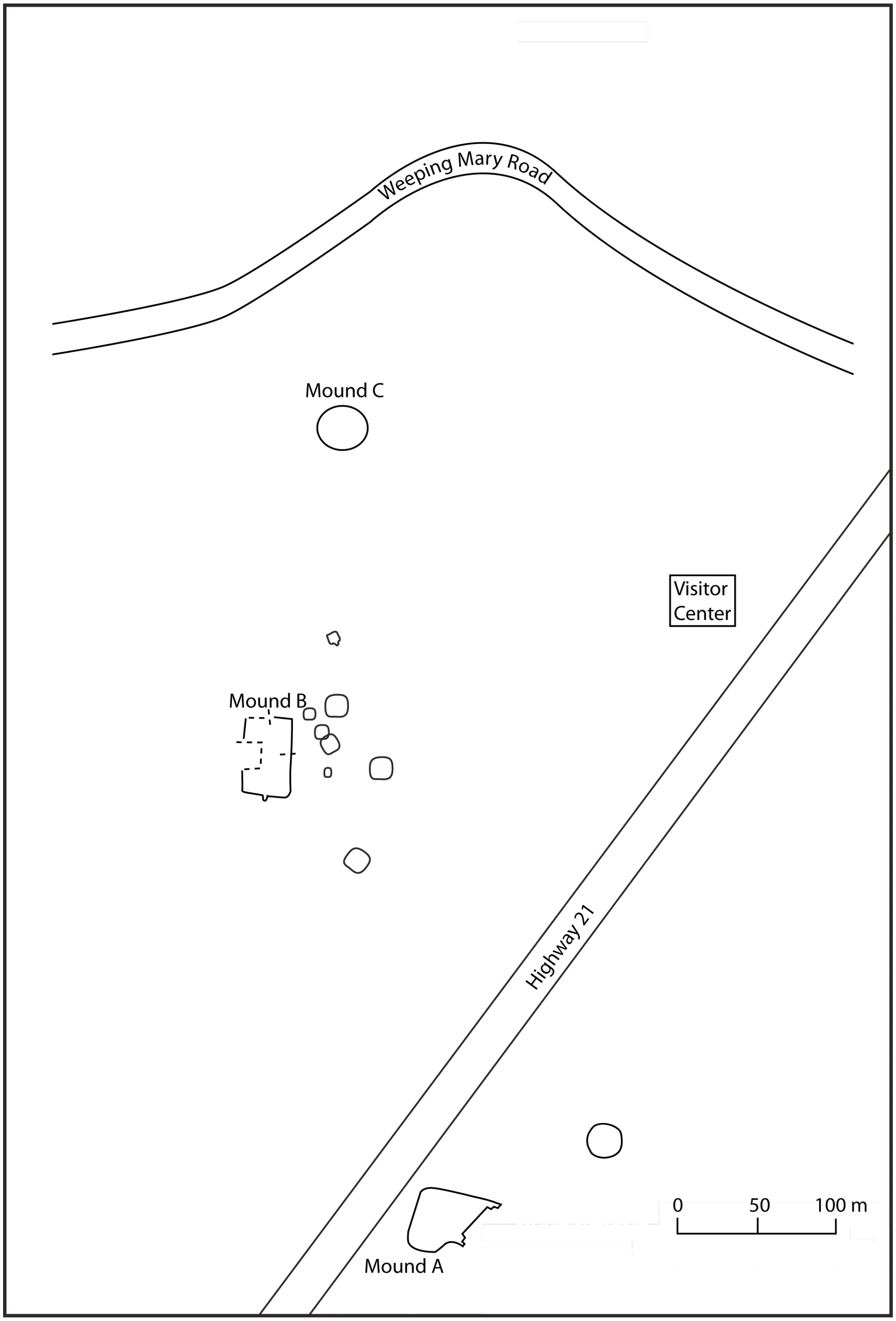

Figure 4.12 Distributions of Type 3 structures.

Sub-Round structures are much more limited in their distribution in both the excavated record as well as the geophysical record. Spock notes that only 6 (11.8% of total structures) structures have this form, and Schultz (2008) identifies 9% of the total geophysical features (n=77) as being Sub-Round. Feature 139 from excavation unit 11, which is located to the north of excavation unit 115, is a clear example of a Sub-Round structure. Feature 139 measured 10.3 to 10.4 m in diameter and was formed by 40 posts. Story (1997:86) noted that the posts slanted outwards, were oval-shaped, and filled with sediment much browner than other posts. Story (1997:86) proposed a connection between the unique architectural characteristics of Feature 139 and the known ethnohistoric architecture form termed by Griffith (1954:99-100) as a “Beehive” house, which was constructed using bent poles. Figure 4.13 is a comparison of Feature 139 and Feature 252 that illustrates the consistency between the excavated and geophysical examples of the Sub-Round structures at the Davis site.

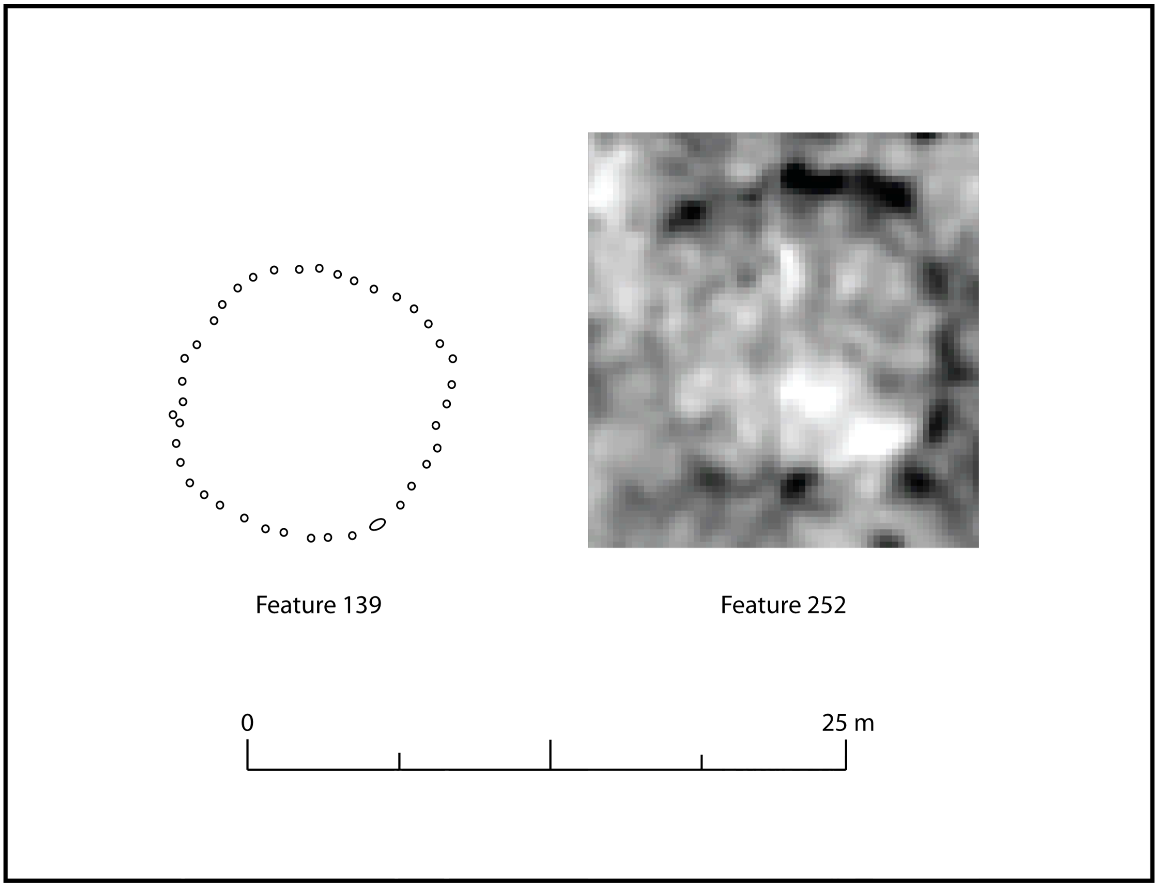

Figure 4.13 Comparisons of Type 3 Houses to excavated structures.

Fire Hearths

The positive magnetic anomalies located in the center of button houses are apparently clay-lined hearths. This interpretation is posited based a fair amount of both primary archaeological information as well as ground truthing data from several of the button house structures (Wilson et al. 2009). Similar anomalies are present in other contexts unassociated with button houses. It is possible that these anomalies are hearths that were associated with a button houses or other circular or sub-round houses that for some reason is no longer legible magnetically. Another possibility is that these represent thermally altered features that were never associated with a formal structure, but were extramural features that were used in the community's open spaces. The distribution of these features (Figure 4.14) shows an interesting spatial trend that clusters with the southern group of type 1 houses.

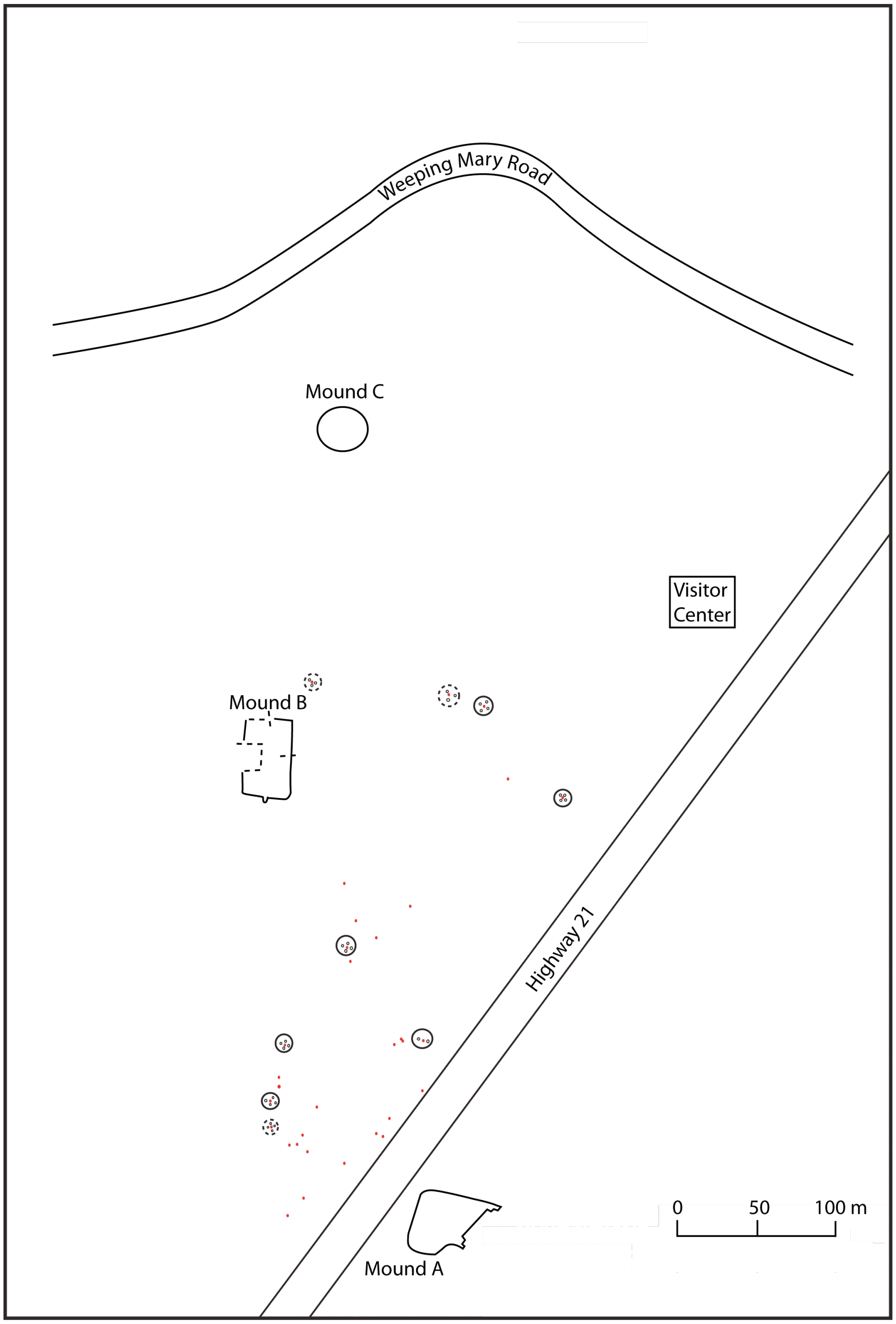

Figure 4.14 Distributions of select positive magnetic anomalies.

Possible Burials

North of Weeping Marry Road is a row of small magnetically low anomalies (Figure 4.15). The row of anomalies runs north/south and the individual anomalies are linear features oriented on an east/west axis. It has been suggested (Creel et al. 2004:10) that these anomalies are similar in size and orientation to that of historic Caddo burials in the Neches River basin. This, combined with the presence of some late prehistoric and protohistoric Caddo pottery in the general area north of Weeping Marry Road (Creel 1979:149-151), may suggest that an Historic Caddo occupation is situated near these possible burial features.

Possible Historic Trail

There are also a series of low magnetic linear anomalies trending east-northeast across this part of the George C. Davis site (see Figure 4.15). Creel et al. (2004:10) have raised the possibility that these linear anomalies are related to the Camino Real de los Tejas historic road. These magnetic low linear anomalies intersect with the southern cluster of possible burials discussed above.

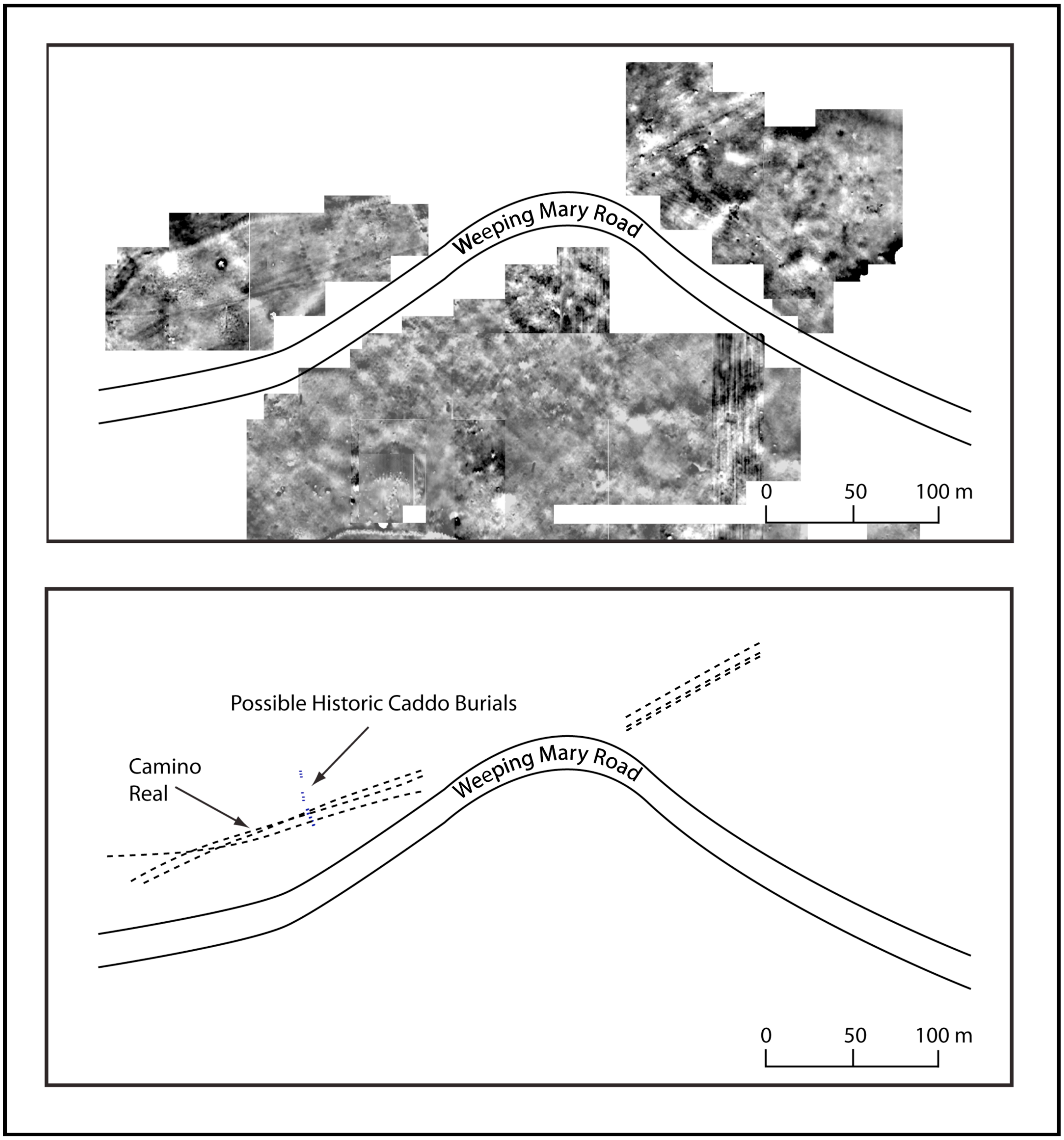

Figure 4.15 Possible Historic Caddo Burials.

General construction phases of Mound B

As mentioned above, Mound B was partially excavated by Story between 1968-1970 with support from the University of Texas and the National Science Foundation (Story 1997:65-75). The mound is a low-lying and flat-topped mound that measures 68 m north-south, 50 m east-west, and is 2 m at its maximum height. Mound B appears to have been built in three separate construction phases, the first of which capped at least two structures at the village level. According to Story's excavations, the pre-mound structures, Features 111, 112, and 120, seem to date between A.D. 980 to 1270 (Valastro and Davis 1970:626-628; Story 1997:65-75 and Figure 24).

Mound B1 measured 40 m north-south, 26 m east-west, and was 2 m high. Story's excavations did not locate a structure on top of mound B1, but she noted that this was possibly due to the intense erosion of the mound and does not rule out the possibility of a B1 structure (Story 1972:63). Neither mound B2 nor B3 are well defined due to continual plowing for agriculture purposes and erosion. This is especially the case for mound B3, which is only present in the trenches on the north flank of the mound, but not apparent in the trenches on the eastern side of the mound (Story 1997).

Story excavated a ramp on the northern flank of Mound B. This was discovered when a series of backhoe trenches (BHT 4 and 13) were excavated into the northern portion of the mound as a means of securing its vertical construction sequences (Story 1997:65-71). This ramp could have also been associated with mound B1; however, from Story's excavations (1997:68) show it more clearly associated with the later mound B2.

The magnetometer data from the Mound B area (Figure 4.16) indicates the necessity of a slight revision to the dimensions of the original (B1) mound. Mound B1 was 5 m wider (east/west) and 9 m shorter (north/south) than had been previously argued (Creel et al. 2008:183). These new measurements are from a series of high magnetic linear anomalies. It appears that there was some kind of trench or small mound of earth used to anchor the mound at the village level, or as suggested by Creel et al. (2008:186), perhaps an enhanced magnetic material was used to face the mound. If this is the case, the geophysical data suggests that the consecutive mound construction phases were designed to increase the height of the mound, not its overall size, since the horizontal footprint of the mound was not greatly increased. These construction phases also did not extend horizontally to the east, which correlates well with Story's excavations in that mounds B2 and B3 were not found on the east side of the mound.

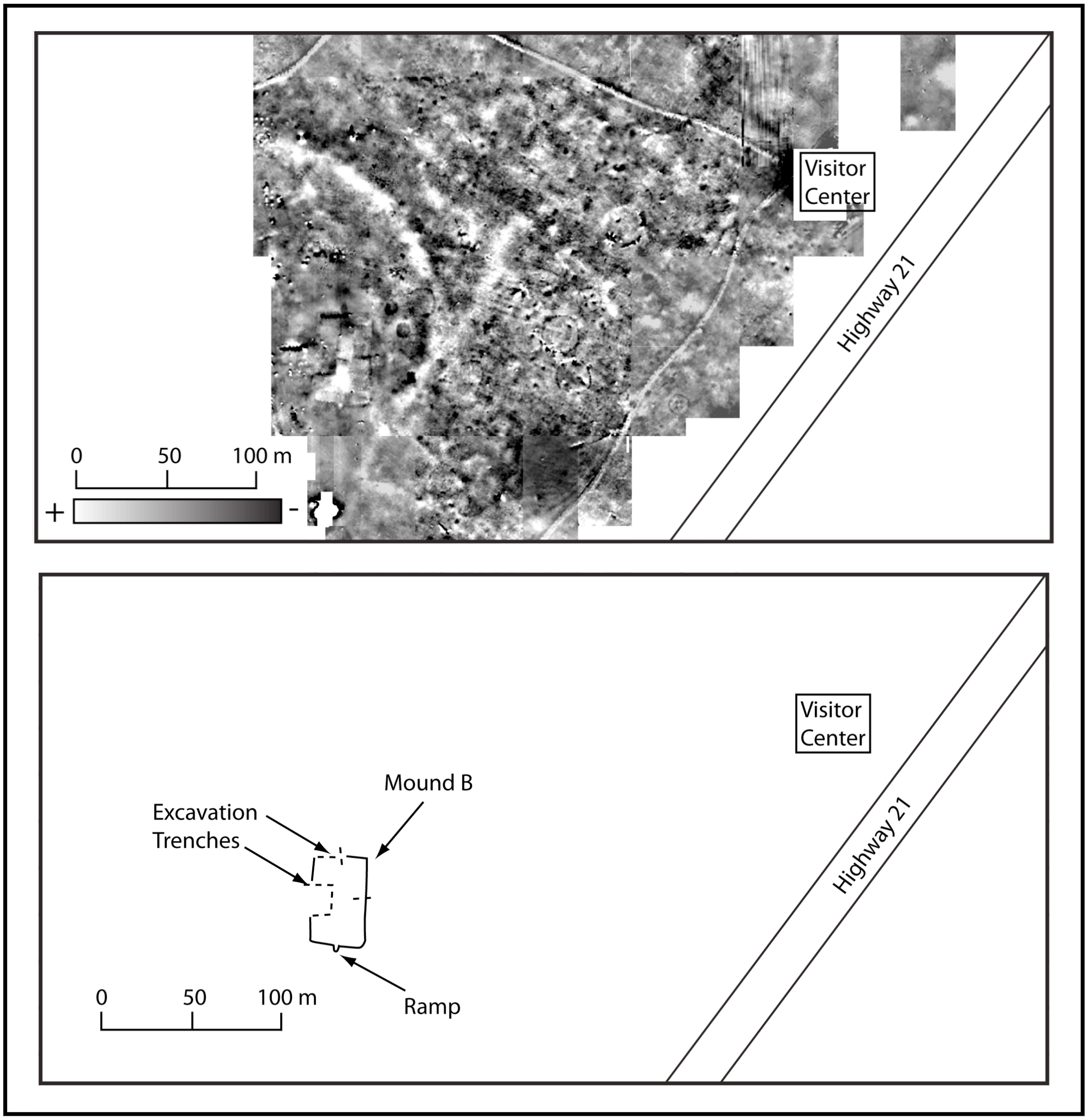

Figure 4.16 Detail of Mound B area.

The magnetometer data of Mound B suggests that there are two additional ramps, one on the southern flank of the mound and one on the eastern flank. This southern “ramp” appears to be an extension from mound B1 (see Figure 4-16).

COMMUNITY ORGANIZATION

Combining the geophysical results with those from the hand and machine-aided excavations at the George C. Davis site has resulted in the most comprehensive architectural database available for an early Caddo community (Figure 4.17); it may also represent the most complete geophysical and archaeological map of any one single Caddo site. In this section I discuss the spatial arrangements of the various structural architectural styles at the site, combined with structural data from the excavated record. The distribution of these structures leads to the initial discussion of the community organization of the Caddo peoples that lived at the Davis site. Furthermore, several possible plazas and community spaces are defined within the boundaries of the site.

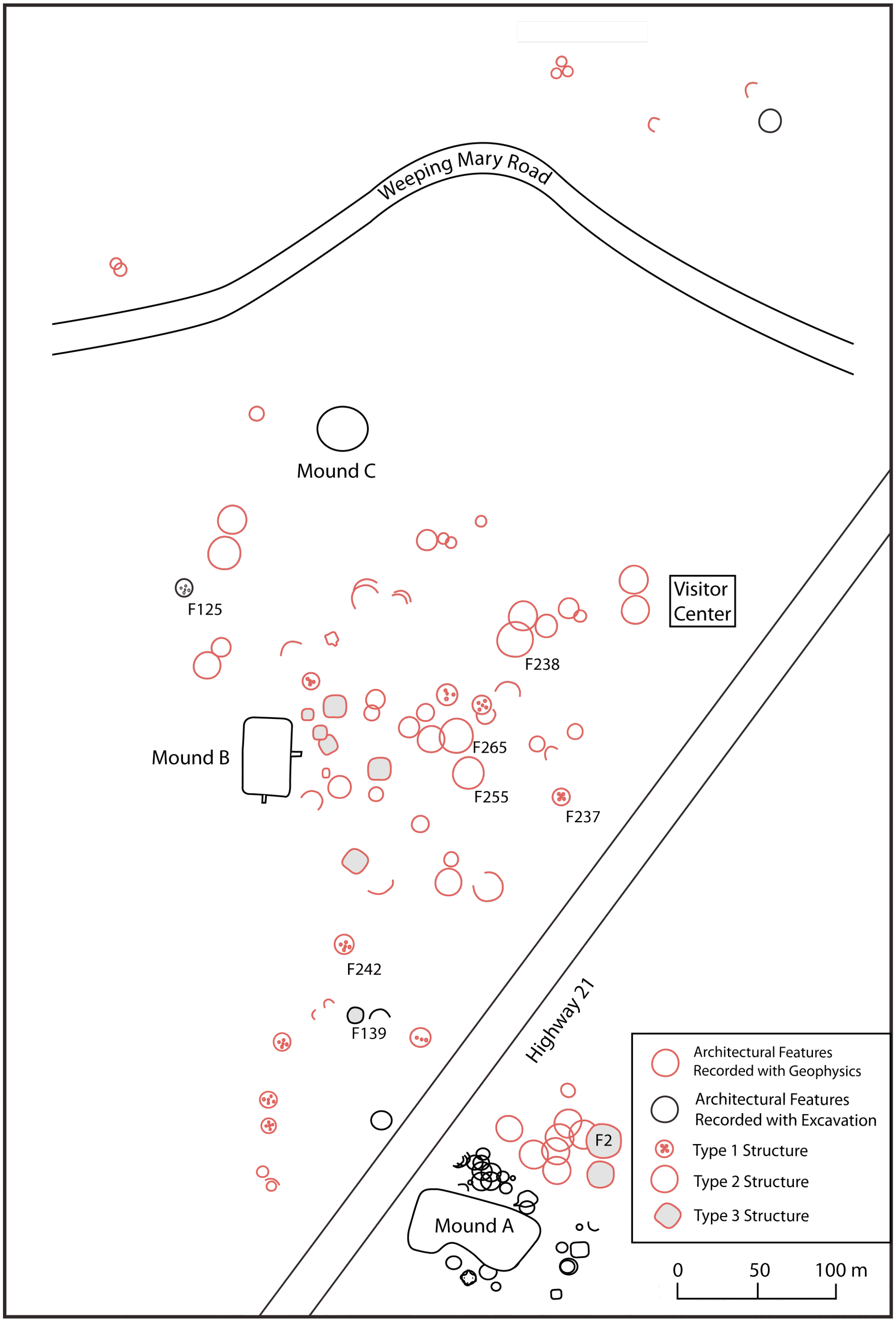

Figure 4.17 Distributions of structures recovered through both geophysics and excavation.

Distribution of Type 1 Houses

The distribution of Button Houses (Figure 4.18) follows the spatial patterning observed above with the defined geophysical features (see Figure 4.9). Button houses appear to be spatially associated with Mounds A and B, or at least the area between the two mounds, appearing with a slightly greater frequency in the southern (or Mound A) portion of the site.

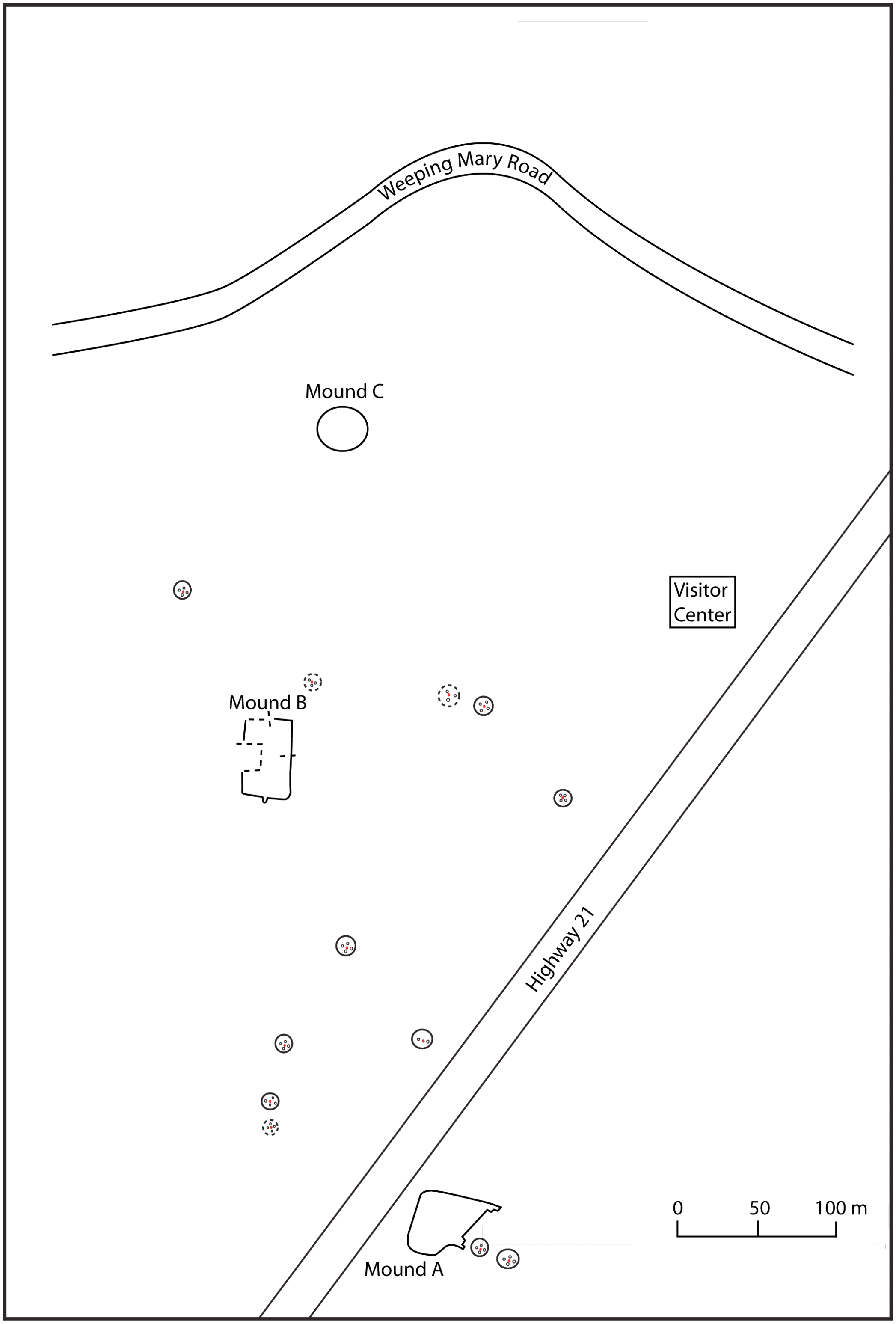

Figure 4.18 Distributions of all Type 1 Houses.

Distribution of Circular Houses

Circular structures are the most prevalent architectural feature in both the geophysical dataset as well at the excavated dataset (Figure 4.19). The excavated database includes three complete circular structures and two possibly excavated structures northwest of the highway and 34 southeast of the highway next to and below Mound A. When the WPA Mound A data is added to the overall distribution map of circular houses, the pattern displayed in the geophysical data is greatly strengthened. Nevertheless, it is important to consider that only a fragment of the total site (with over 30 ha left to survey southeast of Highway 21) has been excavated in the southeastern part of the Davis site. If this spatial patterning of circular structures continues into unexamined areas of the southeastern portion of the site, the patterns presented here will likely warrant modifications.

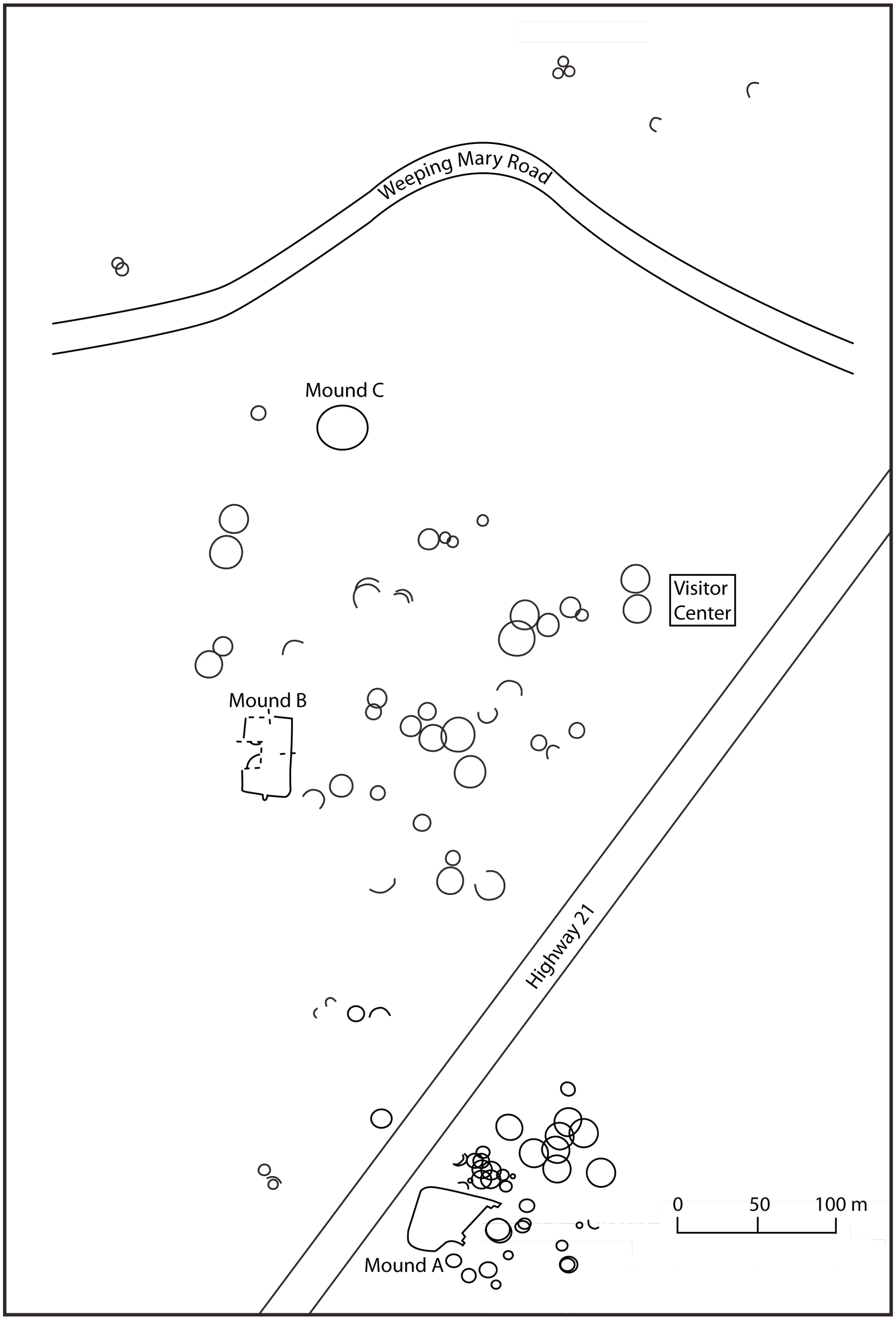

Figure 4.19 Distributions of all Type 2 Houses.

Distribution of Sub-Round Houses

The total distribution of Sub-Round Houses is perhaps the most telling spatial pattern at the site (Figure 4.20). Unequivocally, there is a clear spatial association between Sub-Round houses and proximity to Mounds A and B. Two clusters are present, one centered on and around Mound A and one immediately east of Mound B. Both of these mounds capped structures, and in the case of Mound A, supported structures of various constructions (Newell and Krieger 1949:57-65).

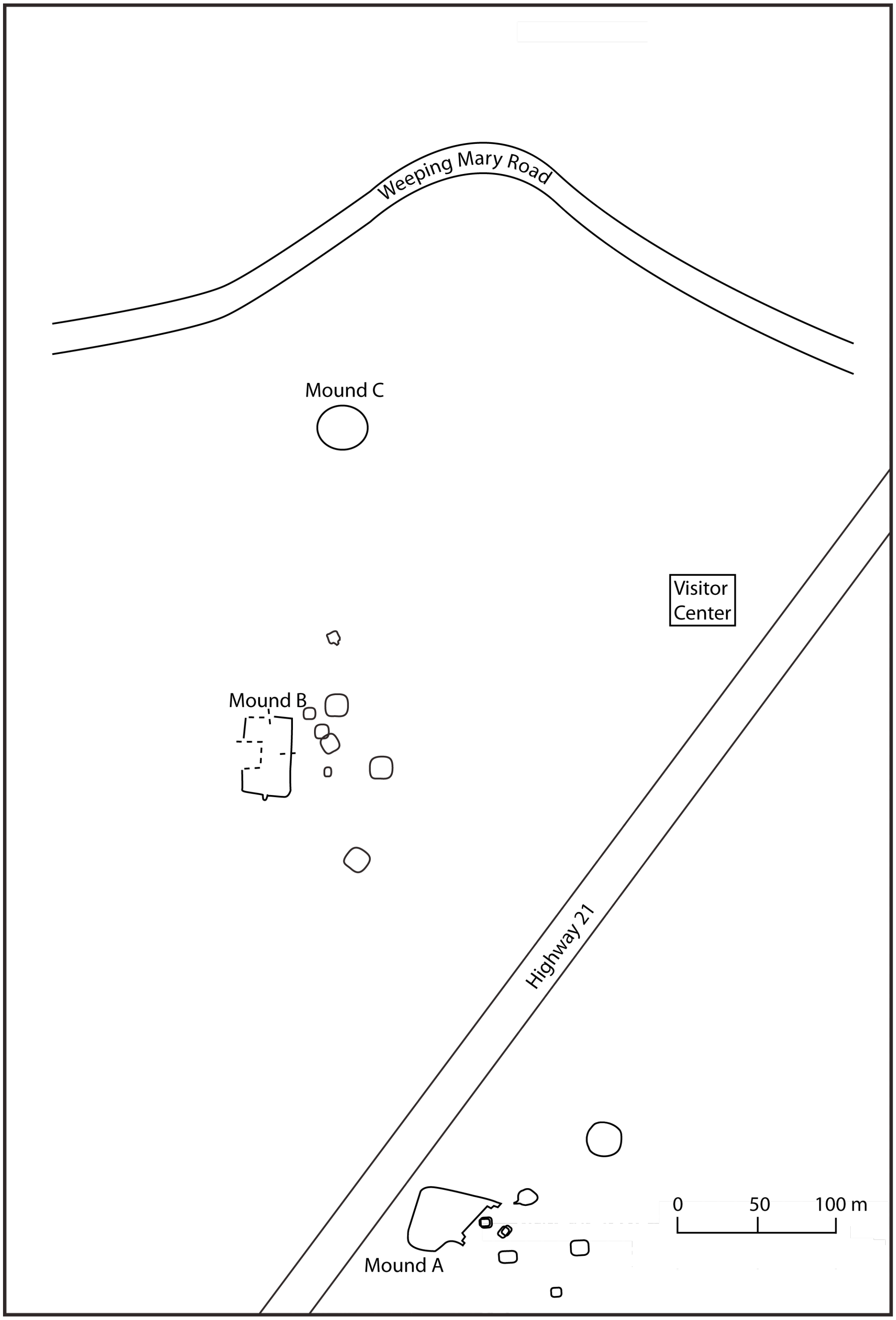

Figure 4.20 Distributions of all Type 3 Houses.

Plazas and Community Spaces

Spatially plotting the Caddo architectural remains at the George C. Davis site defines a complex arrangement of areas of continued structure use and re-building as well as areas that appear to have been left vacant. These vacant areas may represent a series of possible plazas and community spaces; future field excavations should test these possibilities. Unfortunately the southern portion of the site – southeast of Highway 21 and adjacent to Mound A--is too sketchily known from geophysical investigations to yet identify plazas or community space in this area; this will surely change with additional geophysical fieldwork.

Plazas and community spaces are labeled here with dashed lines (Figures 4.21 and 4.22). This is due to the fact that there are no hard lines present in the geophysical data that suggest their presence, in contrast to sites like Jamestown and Etowah where plazas could be identified based on a subtle contrast in the amount of background noise in the magnetometer data (Perttula and Walker 2008; for Etowah see Chapter 3). Instead, the cumulative plotting of architectural features (see Figure 4.17) from the site was scrutinized with the intention of defining such community open spaces. Possible plaza areas are defined due to their proximity to mounds as well as the absence of archaeological and geophysical features. Areas suggested to have functioned as community spaces are located further from mounds and tend to have clusters of structures around them. One might refer to these two kinds of open areas as near mound plaza groups and plaza groups, but the terminology to be used is not the main point. What is important is being able eventually to define, identify, and distinguish community and ritual spaces at the George C. Davis site; and the geophysical data are a large step in that direction.

The area surrounding Mound B appears to have been much more spatially and culturally complex. There appears to have been a series of possible plazas (see Figure 4.22). One of these possible plazas lies to the north of the mound, with another to the south of the mound, both of which would have been accessed by the north and south ramps flanking Mound B. Four additional plazas are identified to the east of Mound B and are defined by the positioning of the densely clustered houses in this area (see Figures 4.17 and 4.22).

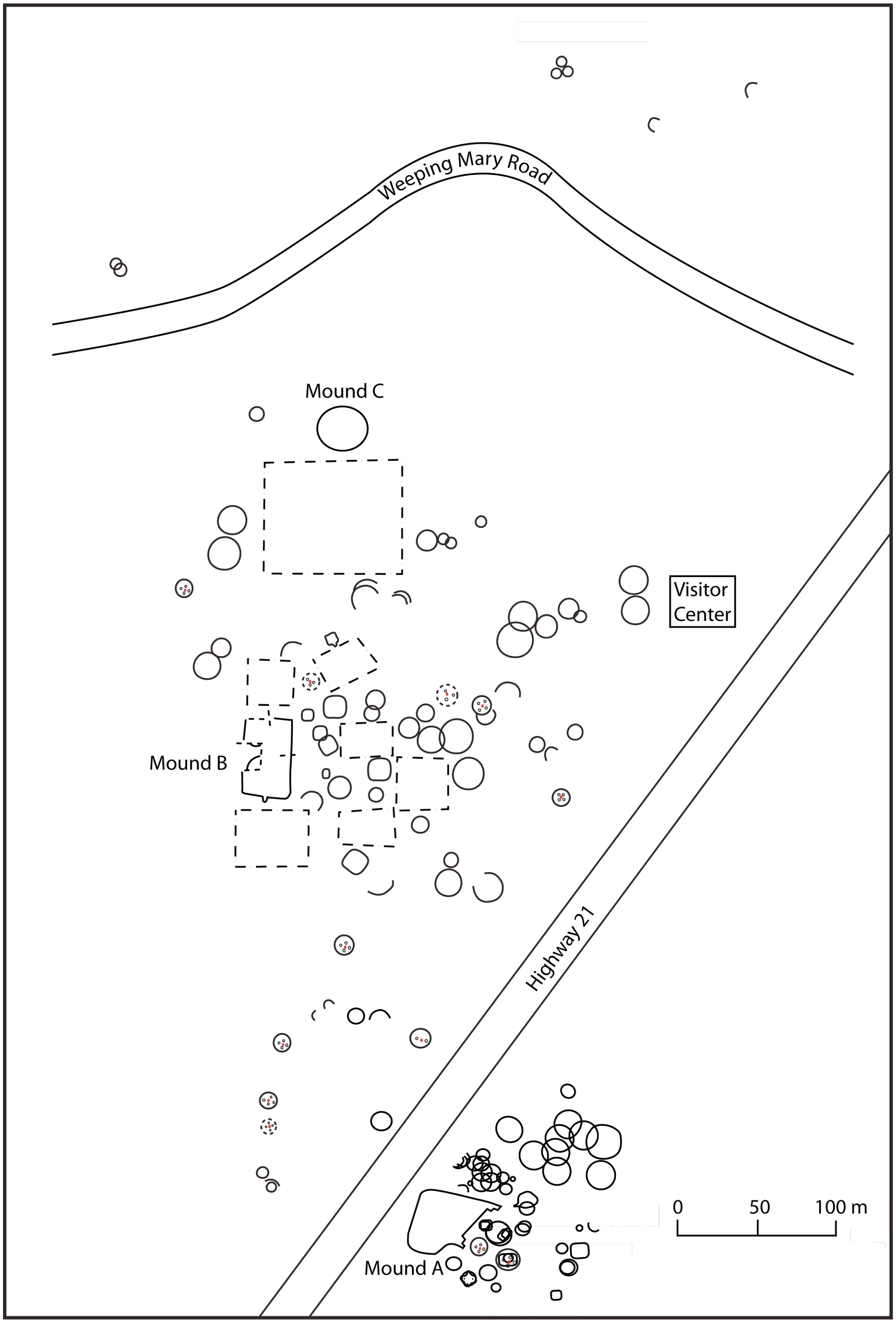

Figure 4.21 Possible Plazas and architectural features.

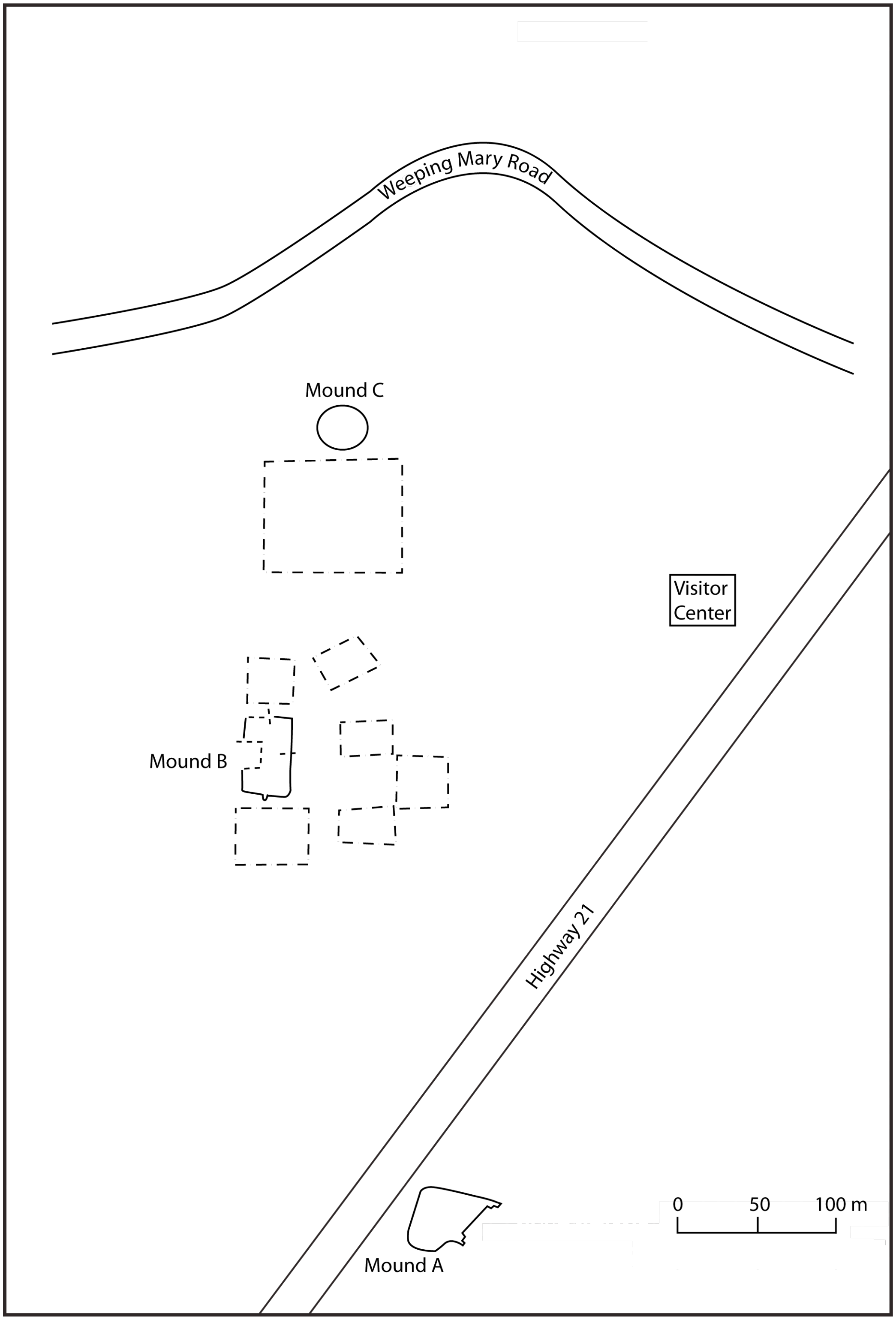

Figure 4.22 Locations of Possible Plazzas.

Summary

This chapter has discussed the history of both archaeological and archaeogeophysical investigations at the George C. Davis site. The results of several magnetometer surveys, totaling over 18 ha, is presented in detail. The geophysical findings and features are compared to, and combined with, the results of the archaeological excavation database from the site amassed through traditional archaeological practices. Finally, I employ spatial analysis to depict the distributions of various architectural forms and community spaces/plaza groups.

CHAPTER 5 – HILL FARM SITE

Introduction

The following chapter presents the findings of a magnetometer survey conducted at the Hill Farm site (41BW169) in May 2005 by Walker and Schultz (2008) as part of the Bowie County Levee Realignment project (Sundermeyer et al. 2008)[3]. First is a brief overview of the archaeological and archaeogeophysical research projects that have been conducted at the site. Next the geophysical data is analyzed and interpreted and contextualized with artifact distributions. Finally the Hill Farm site is discussed in the context of the Hatchel-Mitchell-Moore site complex that was occupied by the Nasoni Caddo from as early as the 13th century A.D. to between ca. A.D. 1600-1700 (Wedel 1978; Perttula 2005). The site complex was visited by European explorers several times, including the 1691 Spanish expedition led by Don Domingo Teran de los Rios (Hatcher 1932, 1999). The Hill Farm site is a portion of the larger Hatchel village (Perttula 2005).

The magnetometer data presented in the published technical report (Sundermeyer et al. 2008) has been reprocessed, reanalyzed, and discussed within the broader context of Caddo archaeology (Walker and Perttula 2007; Perttula et al. 2008). The discussion below summarizes findings from both the technical report (Walker and Schultz 2008) as well as the more recent reanalysis (Perttula et al. 2008).

[3] Lopez Garcia Group, LLC conducted the Bowie County Levee Realignment project for the Fort Worth District of the Army Corps of Engineers.

Archaeological Research at the Hatchel Complex

The Hatchel Complex (Figure 5.1) refers to the series of archaeological sites that extends along the banks of the Red River near present day Texarkana, Texas. This complex included as many as five mounds and several village areas that were organized into individual compounds (Perttula 2005:180). Archaeologically, the site is best known for the Works Progress Administration (WPA) excavations conducted in the late 1930s by the University of Texas (UT) under the direction of William C. Beatty, however, the earliest work at the site was conducted by A. T Jackson of the University of Texas (Creel 1996). The UT/WPA excavations explored the site's main temple mound as well as village and burial plots (Perttula 2005:182). Perttula (2005) has recently summarized these early excavations.

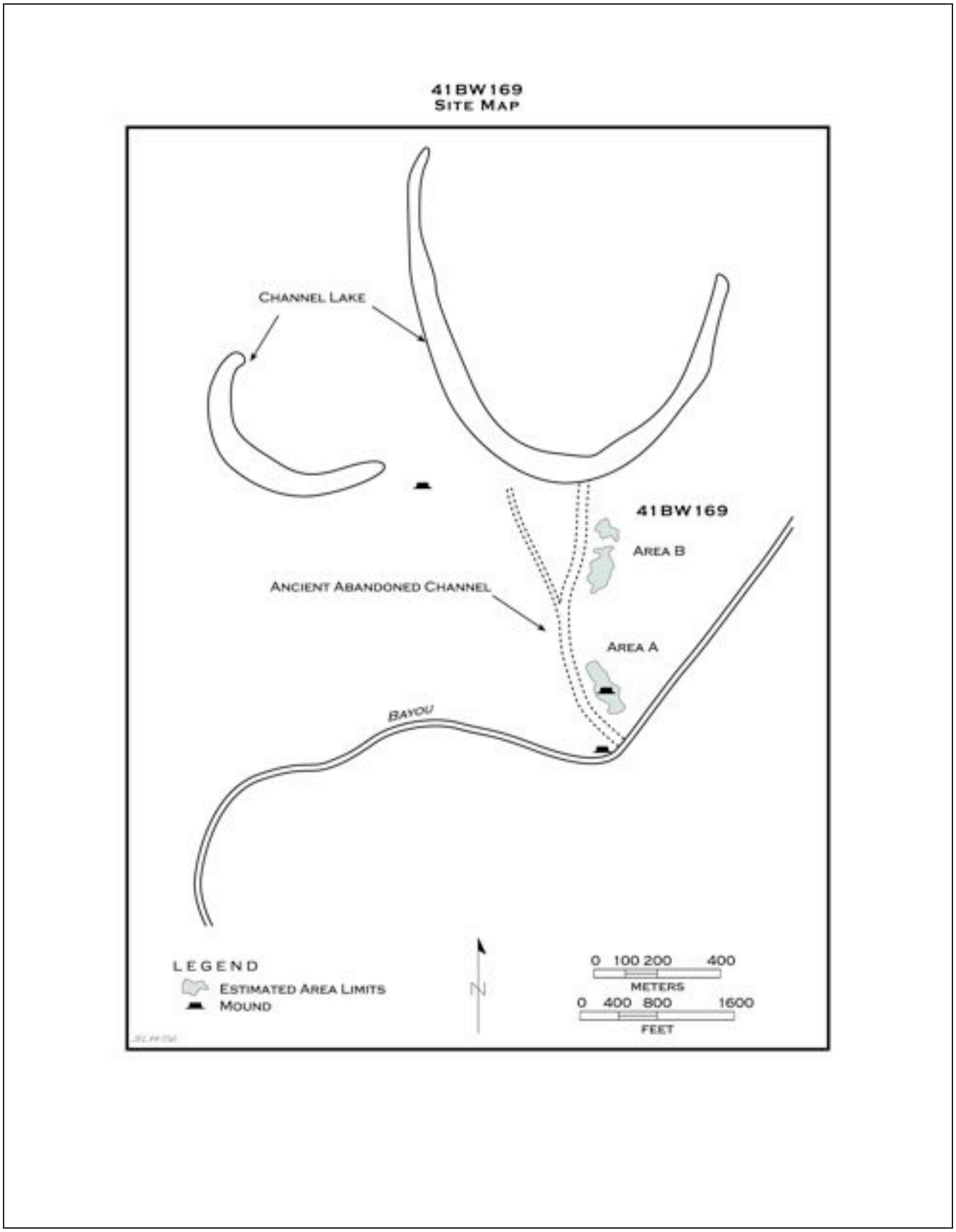

Figure 5.1 Magnetometer collection area locations at the Hill Farm site (41BW169). Image from Perttula 2005.

Archaeogeophysical Investigations at the Hill Farm Site

Archaeogeophysical investigations were conducted at the Hill Farm site as part of a cultural resource management (CRM) project directed by Lopez Garcia Group, LLC for the US Army Corps of Engineers, Ft. Worth district. The Army Corps of Engineers are planning on relocating one of the Red River levees in areas close to the Hatchel-Mitchel-Moore Complex. The archaeological survey designed by researchers from Lopez Garcia Group as well as Archaeological and Environmental Consultants, LLC included the use of geophysics in two stages. First broad scale Electromagnetic Induction (EM) was conducted (Greely and Conyers 2006) successfully locating several relict meander scars of the Red River that were then used to help target a shovel test survey. Next, focused magnetometer surveys were conducted in areas identified by positive shovel testing. The magnetometer results discussed here were collected in an area southeast of the Hatchel Mound that contained three positive shovel tests.

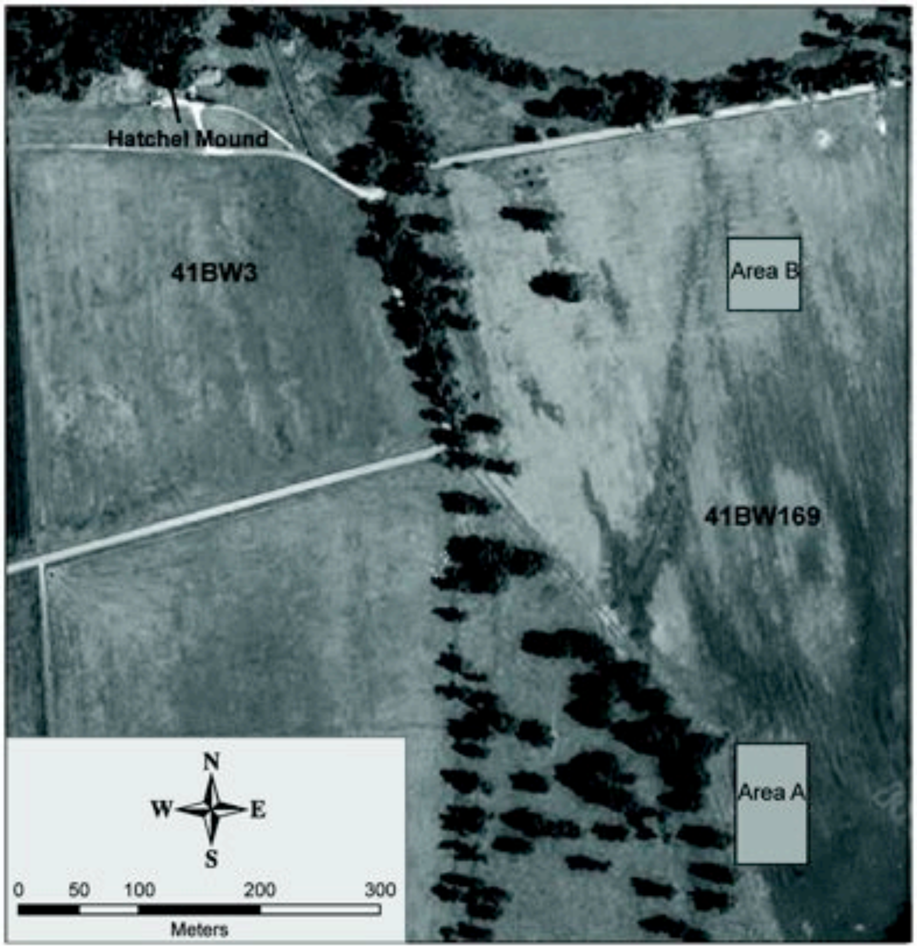

Figure 5.2 Locations of Geophysical Collection Blocks.

Field Methods and Data Processing

Based on results from the shovel test survey, the archaeogeophysical survey at the Hill Farm site was divided into two areas, Area A and Area B (Figure 5.2). Magnetometer data in both areas were collected in adjacent 20 x 20 m blocks that were oriented north-south. A Geometrics G858 portable cesium magnetometer was used configured with a hand-held counter-balanced staff with two sensors spaced 50 cm apart in a total field configuration. The center of the hand-held staff was carried along the survey line, allowing for each sensor to extend 25 cm on either side. Survey lines were spaced at 1 m intervals with data collected on a 0.1 second interval; surveyor pacing was adjusted to collect approximately 10 readings per m. A Geometrics G-856 proton magnetometer base station was used off site to collect data at 10 second intervals in order to record the observed diurnal variation. The diurnal variation, which is the natural and normal changes in the earth's magnetic field, was used to correct the survey data to lessen the effects of these ambient magnetic oscillations, thus allowing the cesium sensors to record the subtle magnetic variations associated with the prehistoric archaeological deposits at the Hill Farm site.

Remote sensing data were downloaded using MagMap 2000. With MagMap 2000, the base station diurnal correction was applied to the files, and grid coordinates were assigned to each collection block. The magnetometer data were imported into ArchaeoSurveyor 2.0 and a composite map of the data was created, combining the individual grids into a master grid.

A de-stripping filter was run on the remote sensing data to equalize the underlying differences between grids caused by instrument drift, inconsistencies during setup, delays between surveying adjacent grids, or variations in the base histogram of the readings for each grid. The median of each traverse is effectively zeroed by subtracted its value from all readings along the traverse. Data were then clipped to $\pm$ 10 nT (nanoTeslas). Clipping replaces all values outside a specified minimum and maximum range. This process is used to remove extreme data point values and aids in normalizing the histogram of the data. Archaeological details are subtle, and having a normal distribution of remote sensing data allows the fine detail to show through with clarity. Finally, the data were interpolated along both the x and y axes.

Survey Results

A total of 24 20 x 20 m remote sensing blocks were collected at the Hill Farm site: 15 blocks in Area A and nine blocks in Area B (see Figure 5.2). Several distinctive spatial patterns have been identified in the magnetometer data that are interpreted as archaeological features, nine in Area A and four in Area B; these are further discussed below. Spatial patterns with regular geometric shapes that represent culturally formed patterns are labeled as features (cf. Kvamme 2003). These interpretations are based on both the visible spatial patterning in the remote sensing data and the known spatial and formal characteristics of prehistoric and early historic Caddo architectural features. None of the features presented here have been ground truthed through traditional archaeological means as have at the George C. Davis site. Shovel test data discussed in Perttula et al. (2008), do, however, indicate that all of these features occur within a broad and patterned distributions of archaeological materials in both Areas A and B. Thus, the Hill Farm site provides an excellent example of a remote sensing dataset that can be used as primary data to further our understanding of both inter- and intra-site settlement dynamics at this Nasoni Caddo village.

CRITERIA USED IN INTERPRETATION

The criteria used for the interpretation of the Hill Farm geophysical data rely heavily on the known character of the sub-surface archaeological deposits at the Hatchel site (Perttula 2005). This, when combined with the high contrast anomalies that are clearly interpretable as Caddo structures, is the basis for our interpretations of these magnetic signatures. Following the geophysical survey, an extended program of shovel testing (Sundermeyer et al. 2008), and a detailed analysis of the shovel test data (Perttula et al. 2008), has identified spatial patterns in the artifact data (and probable midden deposits) that correlate well with the presumed locations of the structures identified in the geophysical data (Perttula et al 2008:101-103) as well as outdoor activity areas.

Modern Cultural Anomalies

Surprisingly, the magnetometer data from the Hill Farm site shows very little evidence of modern cultural disturbance, probably because the site has been shallowly buried by Red River alluvium in the last 100 years. The landform on which the Hill Farm site is situated has of course been plowed and used for various agricultural ends, but this activity is not manifest in clearly identifiable geophysical anomalies.

Geological Anomalies

The western edge of Area A one collection block shows an increased presence of small high and dipolar returns. One possible interpretation for this magnetic trend is the presence of high-energy alluvial gravels containing concentrated amounts of ferrous oxides.

Prehistoric Cultural Anomalies

The archaeological features recovered by the geophysical survey are all architectural in nature. This is not to say that the site does not contain any non-architectural features, quite the contrary. It would, however, take a more systematic excavation program to identify the non-architectural features. There are several different types of house patterns present in the data. These are discussed in more detail below.

Types of Houses

There is a modest amount of architectural variation noted in the magnetometer data from the Hill Farm site (Figure 5.3), however, all the structures can be placed into two architectural forms: houses with extended entrances and circular houses.

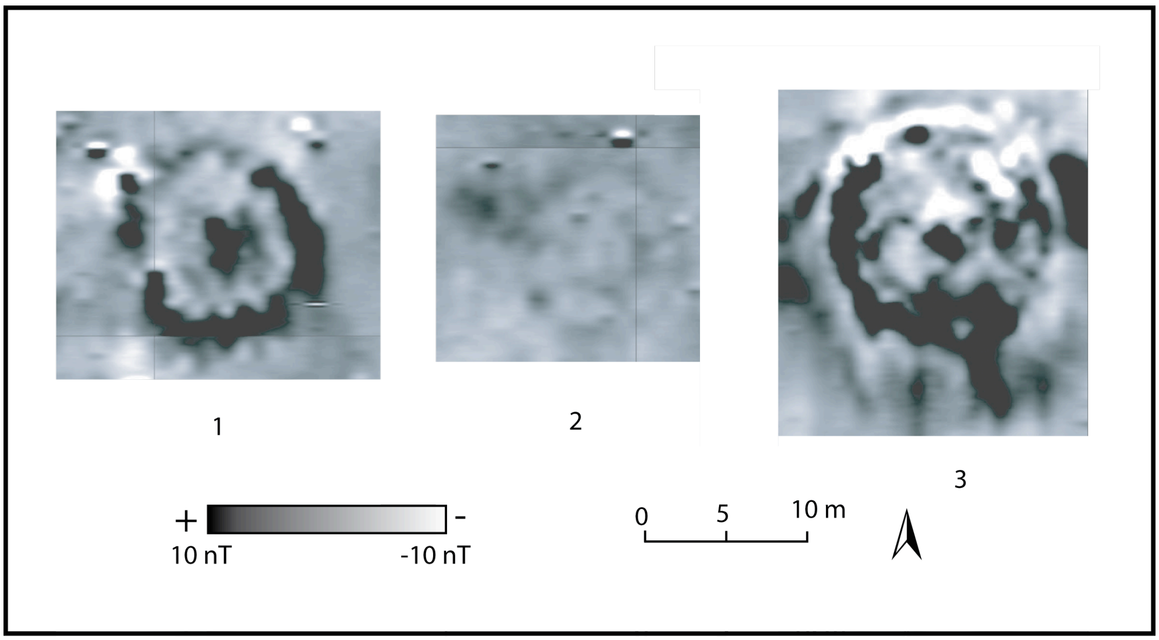

Figure 5-3. Geophysical signatures of various types of houses at the Hill Farm Site.

Extended Entrances

There are two structures present with extended entrances, one in Area A (Figure 5.3 number 2) and one in Area B (Figure 5.3 number 3). Extended Entrance Structures are comprised of a circular magnetic trend with a linear anomaly radiating from a single point. These two structures measure 10 to 12 m in diameter. The structure in Area A opens to the northeast and the structure in Area B opens to the south-southwest.

Circular Houses

Circular houses are comprised of a circular magnetic trend, which at Hill Farm, is a positive magnetic anomaly (Figure 5.3 number 1). There are six circular structures located in the geophysical data from the Hill Farm site and two possible circular structures. Area A has five circular structures all of which have central hearths, and the two possible structures one of which has a central hearth. One circular structure is from Area B. These structures measure between 8 and 12 m in diameter with one exception from Area A measuring 17.5 m in diameter.

AREA A

Nine features are noted in Area A, the southern section of the site (Figures 5.4 and 5.5). Of these, eight are interpreted as domestic Caddo structures (Features 1-2, 4-8, and 13). Features 1, 2 and 4 are all large structures (between 14.5-17.5 m in diameter for Feature 4) with central hearths. In these three cases the magnetic patterning shows a series of positive magnetic returns comprising the outer ring of the structures. Feature 1 is also interpreted as a burned feature due to the large amount of high magnetic returns associated with this feature.

The central hearth varies in its magnetic patterning from structure to structure in Area A. Feature 1.1 has a positive signature, Feature 2 has a central area that is a diffuse negative return surrounded by a semi-circular positive return, and Feature 4 has a small diffuse positive magnetic return just off center.

Feature 3 is a large di-polar return interpreted as either a large borrow pit, where the underlying strata are of significantly higher magnetic susceptibility that the overlying strata, or a burned structure. The small size of the feature (7 m in diameter) and proximity to other houses suggests that it may represent a special use structure, perhaps a granary.

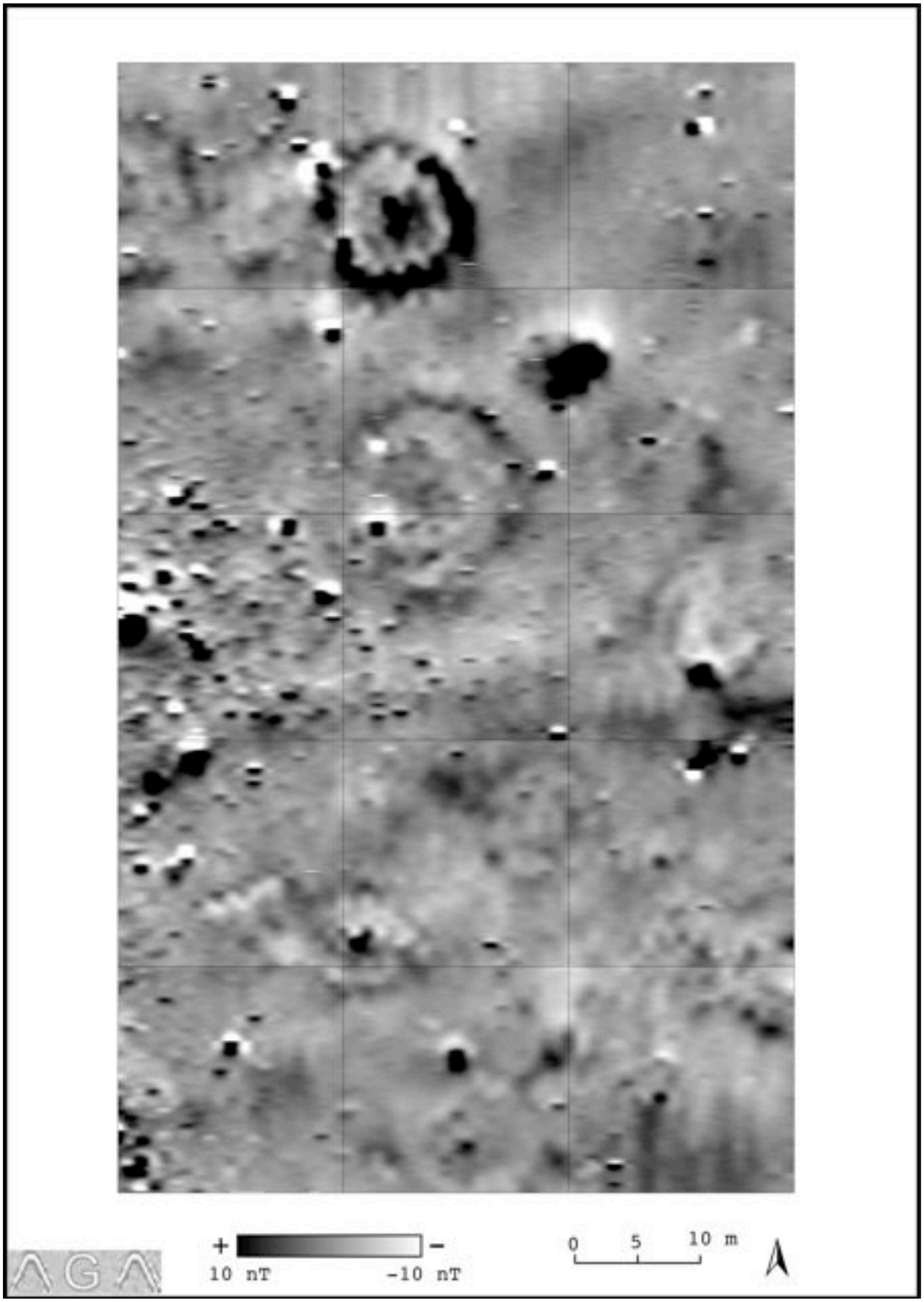

Figure 5-4. Plan of Area A collection blocks.

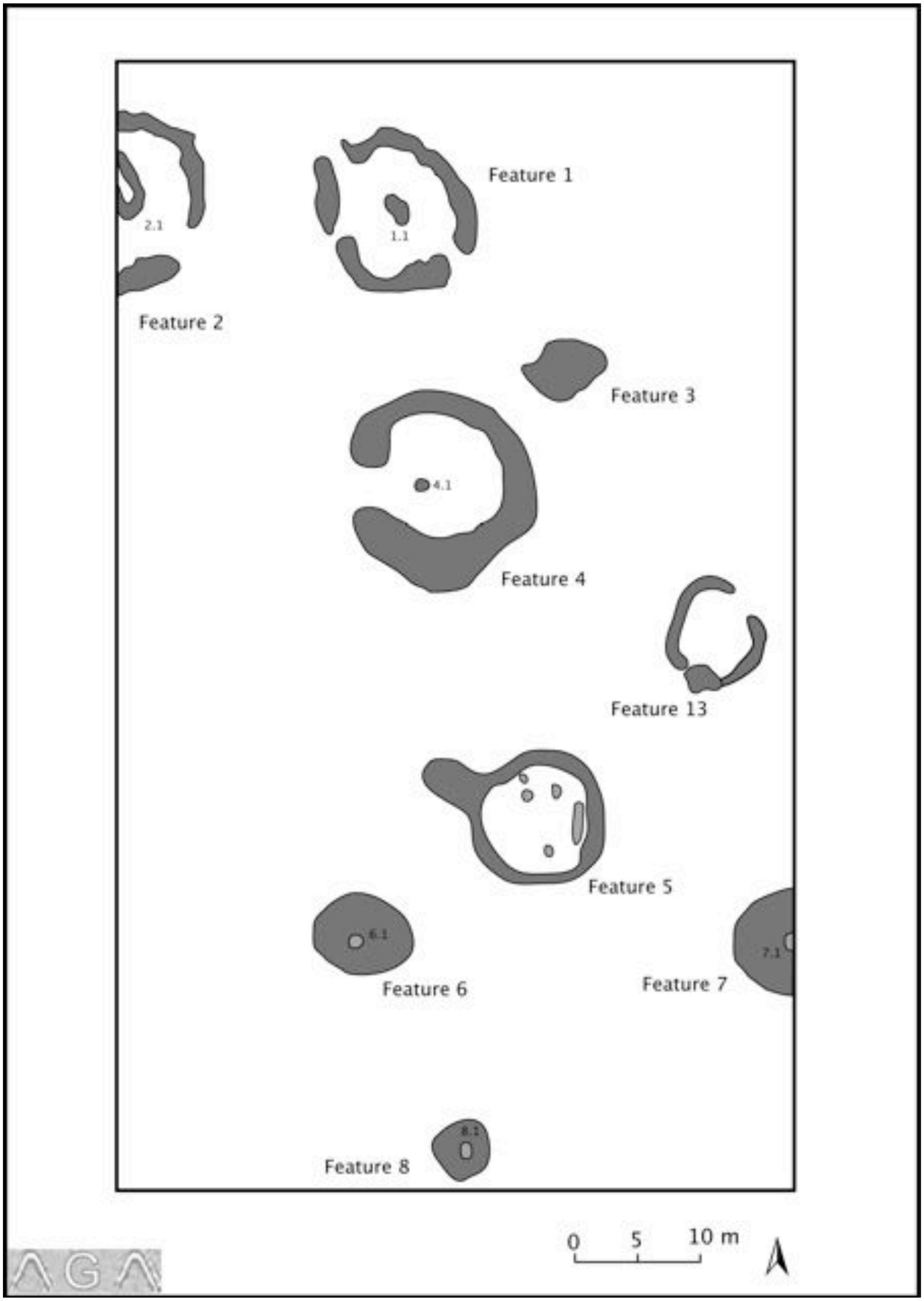

Figure 5-5. Interpretations of Area A features in the remote sensing data

Feature 5 displays another architectural pattern that is well known to archaeologists who work in the Caddo area. The structure is 12 m in diameter and has what appears to be a projection roughly radiating to the northwest (see Figures 5-2 and 5-3) that may be an extended entranceway. Caddo structures often have extended entryways; in fact some of the best examples of this architectural pattern were excavated a little less than 1 km to the northwest at the Hatchel Mound itself. It is even possible that the entrance of this feature is orientated to face the platform mound at the Hatchel site, or a plaza area in front of the mound. Circular structures with extended entrances are relatively common on prehistoric and early historic Caddo sites in northeastern Texas, including the Hatchel site, and parts of northwestern Louisiana and southwestern Arkansas—often found in or under mounds—and they appear to represent special purpose structures probably used by the social and political elite among the Caddo. Feature 5 also has a considerable amount of remote sensing information from within the structure, namely several small positive magnetic returns just inside the walls of the structure that may represent small storage pits.

Features 6-8 and 13 are more geophysically-subtle features that are also interpreted as Caddo house structures (see Figures 5-2 and 5-3). These four features consist of a central positive return with a circular to semi-circular series of returns encircling the central feature. These Area A features are all less than 10 m in diameters, but well within the size range for typical Caddo houses here at the Hatchel site, and various other Caddo sites (see Kelley 1997; Perttula 2005; Spock 1977; Story 1997, 1998, 2000; Webb 1959; Williams 1993).

AREA B

Four features were noted in Area B (Figures 5.6 and 5.7), two of which are interpreted as Caddo structures (Features 9 and 11). Feature 9 is a circular series of complex mono-polar to di-polar returns. The feature has a di-polar return in its center, suggesting the placement of the central fire hearth (Feature 9.1). Like Feature 5 discussed above, this structure feature appears to have an extended entryway. In this case, the Feature 9 extended entranceway points to the southeast, towards Area B. Feature 11 is also a Caddo structure with a mono-polar positive magnetic return in its center representing a central hearth. The mono-polar positive magnetic returns that make up the outside ring of the structure vary from solid high returns to lower and more diffuse returns. Both Features 9 and 11 appear to have been burned due to the high magnetic returns that comprise much of their remote sensing spatial patterning. Both Features 10 and 12 are low diffuse mono-polar linear magnetic returns (see Figures 5.6 and 5.7). These two features flank both the northeast and southwest sides of Feature 11. They may be compound dividers like those depicted on the Teran map (see Perttula et al. 2008:Figure 1) of the Nasoni Caddo village.

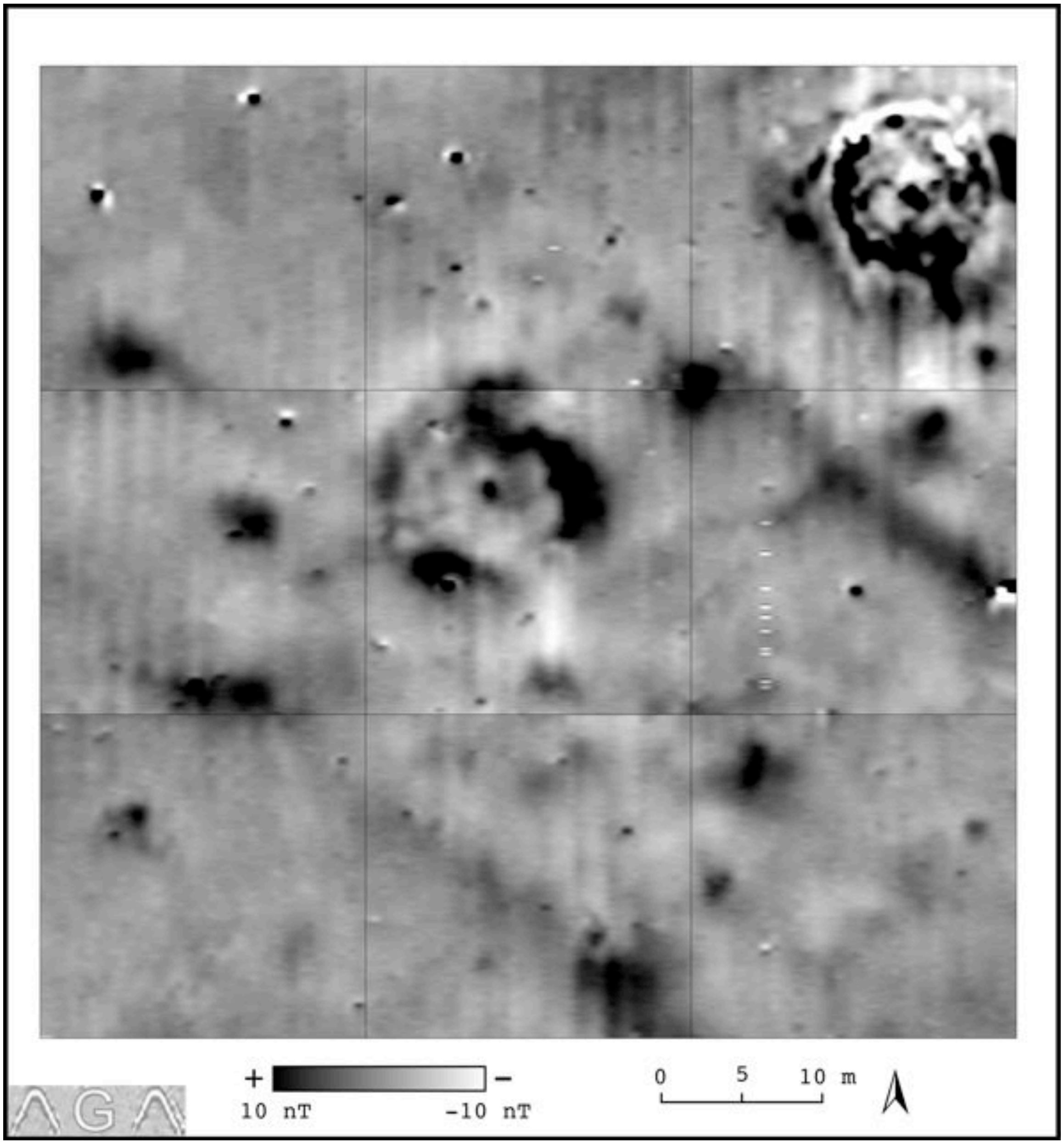

Figure 5-6. Plan of Area B collection blocks.

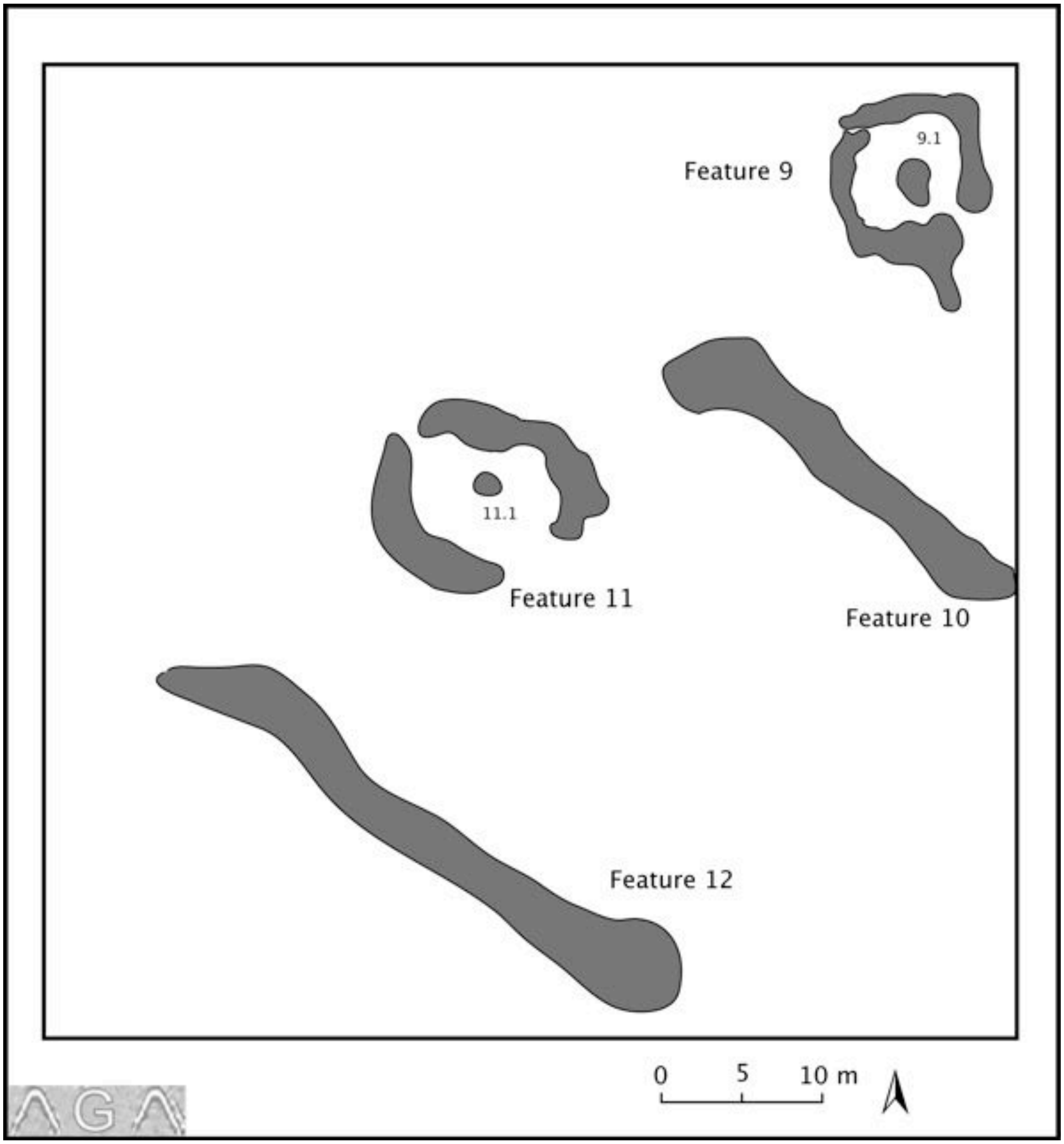

Figure 5-7 . Interpretations of Area B features in the remote sensing data.

Archaeogeophysical Features and Archaeology

By combining the remote sensing data with artifact distributions from the Bowie County Levee Realignment Project (Sundermeyer 2006), it is possible to define several household or community spaces in relation to the geophysical structures. In Area A (Figure 5.8), the artifact distributions suggest the presence of a midden deposit in between features 4, 5 and 13 possibly representing a communal activity area. In between features 6 and 8 is also a concentration of artifacts that possibly corresponds to a midden deposit and possibly a communal space. Features 1 and 3 are located away from the areas of highest artifact density and have been suggested to represent the most recent and least densely occupied features in this portion of the site (Perttula et al 2008:102). In Area B (Figure 5.9) there appears to be a midden deposit associated with Feature 9 and a farm-household compound divider associated with feature 11 (Perttula et al 2008:102). The artifact data south of the Area B remote sensing block suggests the presence of several additional households.

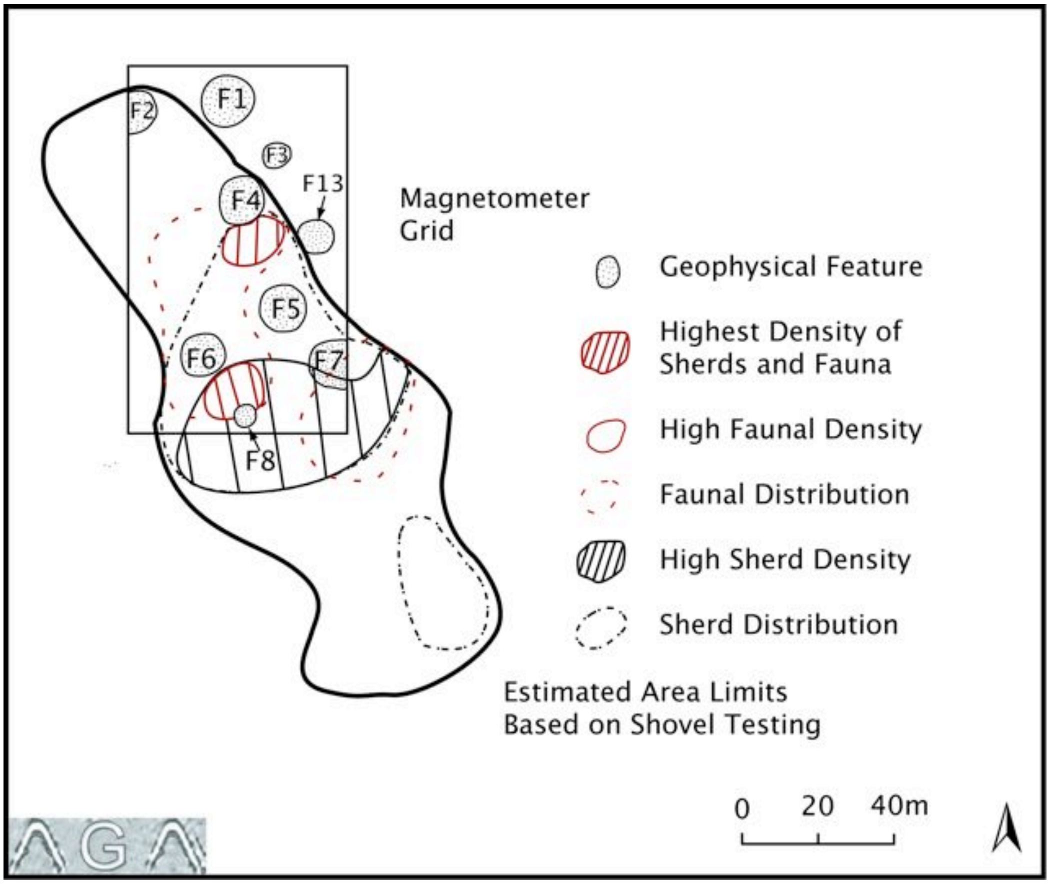

Figure 5-8 Remote sensing features and sherd/faunal concentrations in Area A, Hill Farm site.

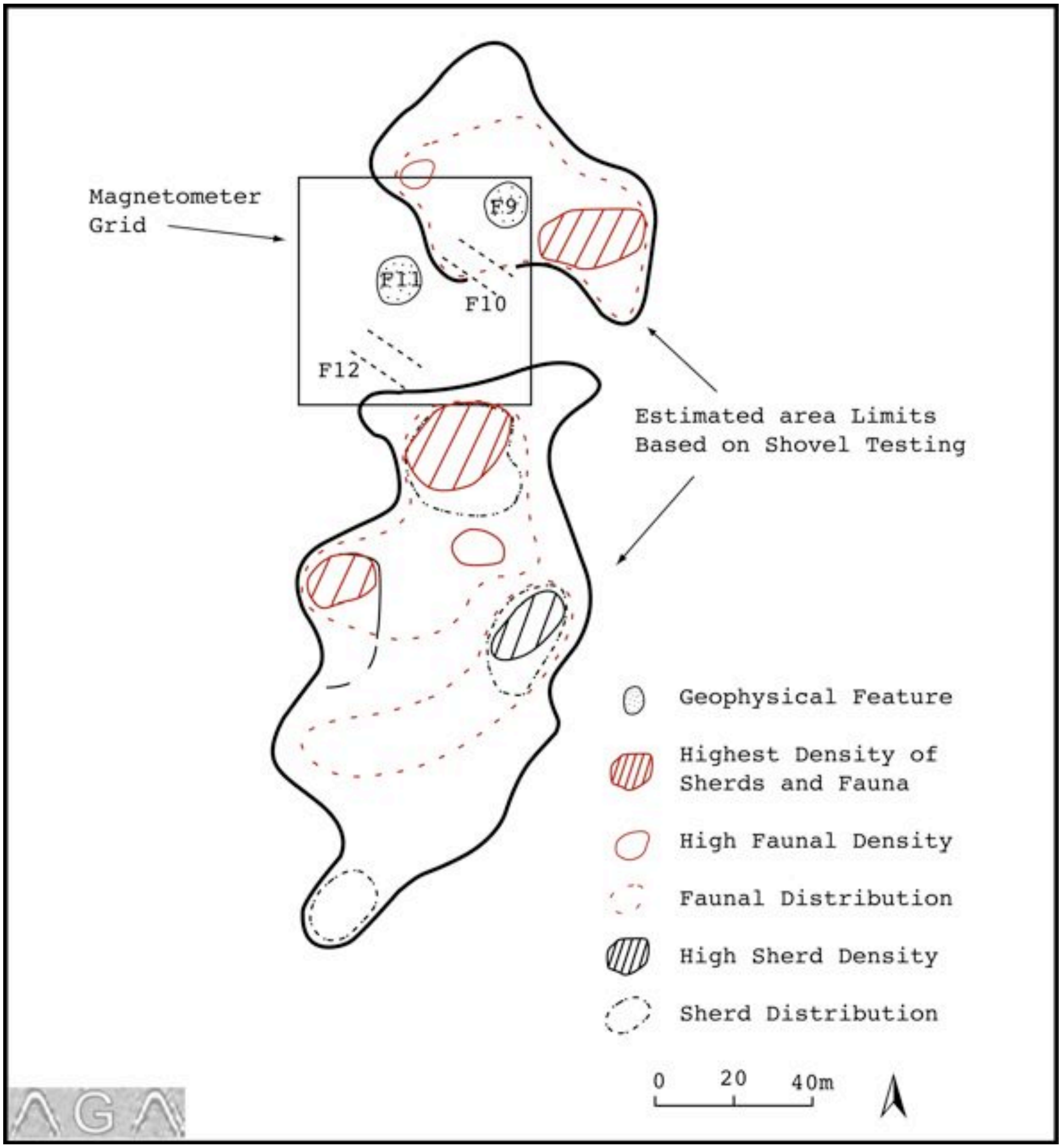

Figure 5-9 Remote sensing features and sherd/faunal concentrations in Area B, Hill Farm site.

Perttula, Walker, and Schultz (2008) recently summarized the archaeogeophysical investigations and archaeological work at the Hill Farm site. They suggest that the site is characterized by an extensive late 17th century Caddo domestic component with at least 10 circular geophysical features that clearly represent structures. Perttula and his colleagues suggest that as many as

25 Caddo structures possibly existed within the boundaries of Area A and Area B, representing as many as 9-10 separate household compounds that were contemporaneously and/or sequentially occupied by Nasoni Caddo families over several generations (Perttula et al 2008:101).

Hill Farm Community Organization

Given the partial nature of the geophysical collections at the Hill Farm site any discussion of community organization will be limited. There are, however, a few important observations to note in this regard. First, both structures with extended entrances seem to open towards the center of the site. This obviously could possibly change with the additional geophysical coverage, but for now it appears to be a pattern. Feature 5 in Area A opens to the northeast – which also happens to be in the general direction of the Hatchel Mound. Feature 9 in Area B opens to the southeast.

Next there appears to be a series of compound dividers associated with feature 11 in Area B. Using the Teran map as the obvious model for community organization at Hill Farm (Figure 5.10), begs the question if it is possible to discuss the actual presence of an individual compound. The long linear anomalies in Area B are curious and given the artifact distributions in this area suggest that feature 11 was possibly built within some sort of divider.

There is additional information to be gained from comparing the Hill Farm data to the Teran map (Figure 5.11). It is possible to pinpoint the very location of the Hill Farm site on the Teran map (Perttula et al 2008:103). An analysis of the pottery from the site, placing Hill Farm in reach temporally from the 1691 expedition; the geomorphology of the area (Grealy and Conyers 2006) which places a stream channel to the west of the site; and the locations of the household compounds, which are located southwest of the Hatchel mound and divided into two discrete areas situated with one to the north and one to the south with a relict stream channel to the west, Perttula and his colleagues argued that the two small compounds located on the Teran map southwest of the "templo" can quite possibly be correlated with the Hill Farm site (2008103).

Figure 5-10 The 1691 Teran Map: the Nasoni Caddo settlement explored and mapped by don Domingo Teran de los Rios in 1691 on the Red River.

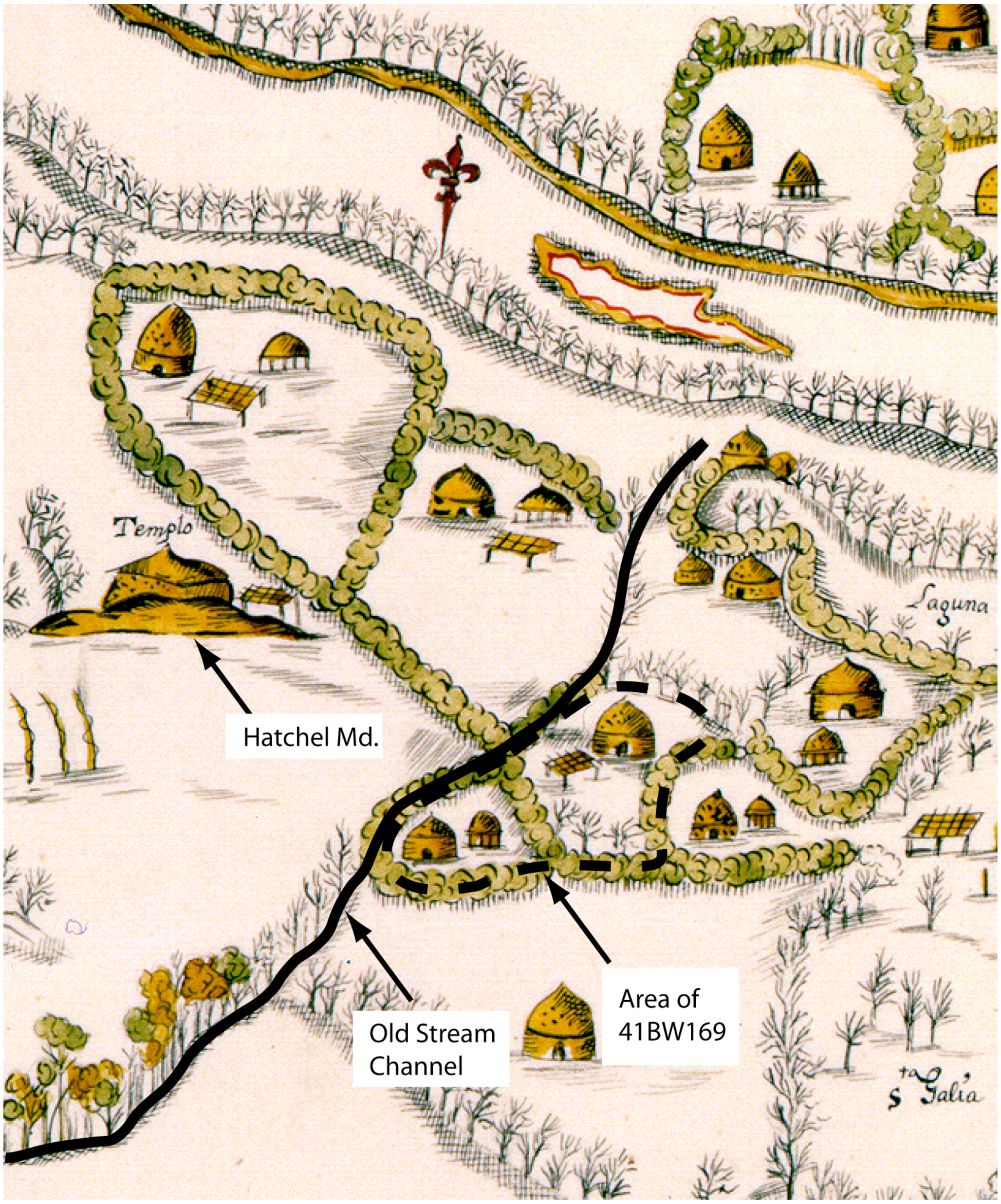

Figure 5.11 Detail of the 1691 Teran map showing the old abandoned channel of the Red River and the household compounds that may represent the likely area of the Hill Farm site.

Summary

In this chapter the archaeology of the Hill Farm site and the larger Hatchel-

Mitchell-Moore site complex, which Hill Farm is associated with was briefly overviewed. A recent geophysical survey was discussed and the results were analyzed and interpreted. The geophysical survey recorded several Caddo structures of different shapes and sizes that can be correlated with specific locations on a 1691 map from the Teran de los Rios Expedition.

Chapter 6, Archaeo-geophysical Data as Archaeological Data

Introduction

This chapter considers the use of archaeo-geophysics as a means of providing a primary data source for the study of landscape archaeology. I discuss several different types of archaeological information, and their resolution, that are the product of archaeo-geophysical surveys summarized in Chapters 3-5. Finally, I turn to the discipline of archaeology in general and offer some insights regarding the development and implementation of a multi-scalar archaeo-geophysical approach.

Kvamme (2003) was the first North American archaeologist to urge a shift from using archaeo-geophysics exclusively as a tool for locating anomalies to a strategy integrated within the larger fabric of archaeological investigation that is often capable of reveling information that warrants archaeological interpretation in its own right. This shift is significant because when the situation allows—as is the case with the geophysical data from Etowah, the George C. Davis site, and the Hill Farm site—archaeologists are able to gain insight into the overall spatial structure of these prehistoric Native American communities without excavation, and indexed at a resolution that is unlikely to be achieved through modern excavation strategies.

From expansive archaeo-geophysical investigations, it is often possible to discuss the arrangements of individual structures along with information regarding their size, shape, and orientation. Furthermore, it is sometimes possible to gather geophysical data relevant to discussing the arrangements of the interior features within a structure. The potential to acquire information of this nature over large areas of sites and landscapes, compared to a slow-paced, expensive, and limited in scope manual excavation, has had an impact on the way archaeology is done now, and will be done in the future in North America. Such an archaeo-geophysical research endeavor has even been described as an archaeological "revolution" of sorts, at least with respect to the future of Caddo archaeological research (Perttula et al. 2008).

Characterization of Architecture

I employ the archaeogeophysical data presented in the three previous chapters on the Etowah, George C. Davis, and Hill Farm sites to highlight the various types of archaeological information that are present, or can be expected to be present, in landscape archaeogeophysical surveys. First, and most apparent, is architectural information, which in high contrast data sets can be used to make observations about structure size, shape, orientation, and distribution, as well as in some cases the arrangements of interior features. Then architectural styles as detected in the archaeo-geophysical surveys are discussed and examples of multiple architectural styles are given from each of the three sites. Lastly, public spaces are discussed, some of which have been defined indirectly by the absence of other architectural elements or other archaeological features, while others are more directly defined by changing trends in magnetometer data.

In all three data sets, the geophysical anomalies that provide the most compelling features suitable for archaeological interpretations are the architectural features. In a very real sense, the landscape analysis advanced for these data sets rests on this fact, since these architectural features clearly represent forms that are pervasive in the archaeological literature of their respective regions and their general patterning leave little room for debate. Perhaps the most interesting finding is not that these architectural features are legible in the archaeo-geophysical data but the amount of information that is present simply in the sizes, shapes, and relationships between these architectural features detected in the archaeo-geophysical investigations.

SHAPES

The most basic pattern of the architectural features is their shape. Shape is the first step necessary in building the interpretative framework that imbues geophysical data sets with archaeological meaning. General trends in architectural shape are present across the archaeological regions in which Etowah, George C. Davis, and Hill Farm are located. In general, Mississippian houses tend to have rectangular shapes, although there are many notable exceptions where there are circular structures at Mississippian sites, including at Etowah (Larson 1994). Caddo structures, at least in the southern Caddo area, tend to have circular shapes, although again there are exceptions, as there are several Caddo sites that have both circular and rectangular houses including the

Hines site (41WD87), Oak Hill Village (41RK214) (Rogers and Perttula 2004), Roitsch (41RR16), Fasken (41RR14) (Perttula et al 2002), Sanders (41LR2) (Jackson et al 2002), Hurricane Hill (41HP106) (Perttula 1990), and Holdeman (41RR11) (Perino 1994). These general architectural characteristics, while not hard and fast rules, are useful for training one's eye for pattern recognition during data interpretation (Kvamme 2008:68).

ORIENTATIONS

Analyzing the orientation of individual houses is a process that continues the interpretative bridge and moves more securely into the familiar realm of archaeological analysis and interpretation. The orientation and arrangements of architectural features provides archaeological information at many levels, particularly the larger patterns that are defined by the net sum of these often subtle intra-site orientations.

INTERIOR FEATURES

The locations and arrangements of interior features, which in the right conditions can be proved by archaeo-geophysical data, provide information about the spatial organization of specific households, while also providing a significant amount of landscape information. At the household level, they offer a starting point to pursuing household scale studies. At the landscape scale, the patterns and arrangements of internal features in different houses should provide insights useful for analyzing different architectural styles and their architectural function (i.e., residential vs. public structures). The most common internal features at

Etowah, George C. Davis, and Hill Farm are the thermo-remnant anomalies created by fire hearths.

ARCHITECTURAL STYLES

One of the most promising details present in all three of the data sets in this study is the ability to identify individual architectural styles of structures. This brings into play a considerable amount of archaeological data already obtained from the three sites, and with the case of Etowah, allows the analysis to move into the temporal domain, leading to the development of diachronic models of the prehistoric landscape.

Mississippian Houses

In the data from Etowah it is possible to discern two well known Mississippian architectural styles (Lacquement 2004:110-141). During the Early Mississippian phases (A.D. 1000-1200) the general architectural style consists of wall-trenched houses that typically were constructed with small poles that at times were placed in double rows to help add support to the walls (Hally and Rudoloff 1986). Around A.D. 1200 there was a shift towards the use of larger poles for house construction that were typically placed in single rows. These structures did not typically have wall trenches and often had a basin-shaped floor (Hally and Rudoloff 1986). This architectural variation is legible in the magnetometer data from Etowah, which in turn makes it possible to identify and spatially plot the houses that were constructed before A.D. 1200 and those that were constructed after that time.

The wall-trenched houses are defined geophysically by a linear positive magnetic signature that is rectangular in shape. This signature is interpreted as a negative relief feature filled in with an enhanced magnetic soil: archaeologically, represented as a filled-in wall trench. In some cases there is a small circular positive magnetic signature in the center of this rectangle that is interpreted as a fire hearth.

The single set large pole basin-shaped structures are defined geophysically as a rectangular-shaped and complex bi-polar signature. This signature is interpreted as the mass of daub (burned clay) from the collapsed walls of the structure. This mass of daub, which is magnetically enhanced, comprises an obvious and easily recognizable anomaly, but unfortunately an anomaly that also masks any internal details of the structure.

Caddo Houses

There are several different architectural styles present at the George C. Davis and Hill Farm sites, the two Caddo sites in this study. At both the George C. Davis and Hill Farm sites, the basic architectural style is that of a circular structure. These circular structures are defined at the Davis site by a circular low magnetic signature, believed to have been created by negative relief features extending into a magnetically enhanced ferrous subsoil filled with less magnetic soil (Bruseth et al. 2007; Creel et al. 2005, 2008; Osborn et al. 2008). At the Hill Farm site the circular structures are defined by a circular magnetic high trend that is believed to be the result of thermo-remnance (Walker and Schultz 2008; Perttula et al. 2008).

At the George C. Davis site, there is a second architectural style that is characterized by a central fire hearth (a thermo-remnant positive magnetic anomaly) that is surrounded by four interior roof support features (large magnetic low anomalies). Excavations have confirmed these interpretations at four of these structures from the site (Wilson and Schultz 2009).

At the Hill Farm site are a few circular structures that have extended entranceways. This is a familiar pattern found throughout the much of the southern Caddo area and has been a source of recent inquiry (Kay and Sabo 2006; Perttula n.d.). Using archaeological information from the Arkansas River Valley and Ozarks, as well as ethnographic information from the Hasinai Caddo of East Texas, Kay and Sabo (2006) suggest that the extended entranceway structures in this area, which are almost always rectangular in shape, carried an architectural grammar that was influenced by the general world view of the Caddo, especially their views about death. Kay and Sabo (2006) maintain that these entranceways are oriented toward the southwest, because that direction for the Hasinai Caddo symbolizes death. They extend this argument to suggest that this symbolism can be used to infer a unique function for extended entranceway structures, suggesting that they were used as mortuaries or charnel houses (Kay and Sabo 2006). In contrast, Perttula (n.d.) found that most Caddo extended entranceway structures are circular in shape, and have a variety of orientations, most having little to do with death symbolism among different Caddo groups.

Delineation of Public Spaces

Public spaces are clearly visible in the magnetometer data from the Etowah site, and to a certain extent at the George C. Davis site. These spaces are both defined by the patterned absence of architectural features as well as the actual arrangements of architectural features within them. The most obvious example is the northern plaza group at the Etowah site. Etowah also has a few other public spaces defined in part by geophysics. The areas directly adjacent to the site's three main mounds (A, B, and C) are most clearly defined by the location and orientation of the mounds. Geophysics does help to strengthen this pattern simply by defining areas with an absence of groupings of structures such as those located on other parts of the site. There are also anomalies situated in centralized locations within the larger spatial patterns defined by the mounds. At the George C. Davis site, public spaces are not as clearly legible but are suggested by the absence of structures as well as the proximity of these areas to the site's three mounds. It is not apparent if there are plazas at the George C. Davis site.

There are some obvious pitfalls that should be pointed out regarding the analysis of public spaces using geophysics. First, as previously mentioned, by definition, magnetometer data is two-dimensional and represents the net sum of magnetic fields. Thus, objects (and their resulting magnetic fields) that are located at varying depths or are of differing ages are all compressed into a single image. Magnetometer data can be described as an archaeological palimpsest. In that case, the possibility exists that other plazas at Etowah or George C. Davis were present at each site, but have been erased or overwritten, to continue the palimpsest analogy, by the magnetic enhancement of the soils resulting from continued cultural activity. There is also the issue that the absence of data is not data of absence (Gaffney 2009:202).

Visualizing the Overall Site Layout

At it most basic and perhaps analytically most powerful level, the use of geophysical data in landscape archaeology permits a more complete image of the overall site layout and internal organization of structures, mounds, and other features to be obtained than is possible through traditional archaeological methods. Even if excavations can refine the details of the interpretations of individual anomalies, a broad-scale site plan fills in the huge gap in the archaeological data base in areas where earthen architecture was not used and the patterning of structures are not otherwise readily visible from surface or near-surface archaeological deposits.

The archaeo-geophysical data from the Hill Farm site unfortunately does not cover the entire site, let alone the entire prehistoric landscape of the Nasoni Caddo community to which it belonged. Fortunately, we supplement this through the use of historic documents to better understand the internal layout of this one part of a 7-9 km long community of farmstead compounds. The well known map from the 1691 Teran de los Rios expedition of the Upper Nasoni village, believed to be at least in part the current day Hatchel site (Wedel 1978; Perttula et al. 2008), provides archaeologists with our best and most complete depiction of how the Caddo constructed and used the landscape, at least at that time in their history. Archaeo-geophysics has been used to help strengthen our understanding of how Teran's map is not just an image to be used as a generic model of Caddo community organization (cf. Lockhart 2007a) but can be viewed as an actual map (drawn to scale) of a Caddo community at a specific point in time (Perttula et al. 2008). Geophysical techniques were used at multiple spatial scales to target resolving both the nature of the Caddo settlement in part of the Nasoni village explored at the Hill Farm site, but also to help aid in the environmental reconstruction and relocation of buried stream channels and relict meander scars of the Red River (Grealy and Conyers 2006; Conyers et al 2008) that are accurately shown on the Teran map.

Continuing To Refine Landscape Archaeo-Geophysics

As Berle Clay has noted, “one should end any geophysical survey with the caveat, ‘pending further archaeological examination, I think . . .’ ” (Clay 2003:6-7). This highlights the importance of acquiring traditional archeological data, particularly information on the structure and character of the archaeological record from excavations, that is closely integrated with the geophysical survey data from the same site or group of sites. As such, the geophysical survey data can be viewed “as an extension of the archaeological record that includes measures of electromagnetic spectra beyond the human visual range” (Lipo et al. 2004:79). Each form of data, whether archaeological or geophysical, constitute independent but different kinds of information about the archaeological record under investigation; the synthesis of both is a necessity. The application of archaeo-geophysics should not be constrained to simply locating anomalies. Likewise, archaeological excavations conducted alongside archaeo-geophysical surveys should not be constrained to “ground truthing” anomalies. Limiting these two methods in this manor not only limits their utility but in-fact enhances their weak points.

Landscapes and Geophysical Data

An exciting possibility that archeo-geophysics offers is the potential for joint research investigations that can focus attention and study on prehistoric landscapes and communities at a greater degree of resolution that has previously been possible. The geophysical data from Etowah and the George C. Davis sites cover around 20 ha each. Eventually these entire sites will be investigated by geophysics; however, they already provide us with the most complete spatial picture of Middle Mississippian and Early Caddo ceremonial centers, and possibly the most complete view of any Mississippian or Caddo site. Surveys at a comparable scale to Etowah and the George C. Davis site are currently being conducted at the Double Ditch site, a historic Mandan site in the northern Great Plains (Kvamme 2008), the Kincaid and Angel Mound sites, Mississippian sites on the Ohio River in the Midwest and Southeast, and at Battle and Crenshaw, Caddo mound centers sites on the Great Bend of the Red River (McKinnon 2008; Samuelson 2008) in southwestern Arkansas.

Archaeology operates at varying degrees of spatial resolution. Sites are recorded across the landscape using techniques such as pedestrian survey, surface collecting, shovel testing, and air photo interpretation. These techniques are designed to locate sites and make general observations regarding their relative size, age, and in optimal conditions their character. There is a tacit acceptance that these survey techniques are not effective at discovering 100% of the archaeological sites in any survey area (Black and Jolly 2003:87). These efforts are, however, thought to be the most practical by the archaeological discipline in that they represent the most effective solutions for discovering and recording sites and that the overall patterns of site distributions will be comprehensive enough to warrant regional interpretations and synthesis of settlement patterning, etc.

These same issues of practicality and efficiency have been discussed regarding the adequacy of archaeo-geophyscial surveys. English Heritage conducted a follow up analysis on six archaeological sites that were surveyed with magnetometers and then later extensively excavated (Linford and David 2001). This study, known as the Planarch Document, compared the results of the geophysical survey to quantify the success rate several different archaeological methods such as auguring, trenching, excavating test units, as well as geophysics (Linford and David 2001). Vector polygon overlays were used to compare the results of the geophysical surveys to the excavated areas. True Positives were cases where there was a direct correlation between geophysical anomalies and excavated features; these were also further quantified into buffer zone groups from 0 – 2 m. False Positive were geophysical anomalies that did not correlate to archaeological features. True Negatives were cases where nothing was found within a 2 m buffer of the identified area. False Negative were recorded archaeological features that failed to produce a geophysical anomaly. True positives ranged from 58.9%-83.3%; false positives from 41.1%-16.7%; true negatives from 35.1%-86.9%; and flase negatives from 20.4%-78.4% (Linford and David 2001:81 table A2.2). This data was used by Linford and David (2001) to conclude that the results of archaeo-geophysic surveys on known sites was less than successful, a statement that has been criticized due to alleged inconsistencies in the data collection methodologies of the individual geophysical projects used in the study (Gaffney 2009:202).

Turning this conclusion on its head, it is fair to conclude that even the

58.9% rate for true positives determined in the Planarch study's lower scale would rate as a success by most measures. If an archaeo-geophysical survey only recorded 58.9% of the actual archaeological features at a site, it still seems clear that this would be considered by an archaeologists more than likely sufficient to reveal many of its important cultural patterns at the landscape scale. By judging the success of archaeo-geophysics solely on its ability to pin-point individual archaeological features (and a 58.9-83.3% true positive success rate is positively robust) greatly undermines one of its most unique abilities: to rapidly map larger areas that could contain features than can be accomplished through traditional archaeological methods. A single-minded focus on feature locating constrains the utility of archaeo-geophysics by expecting it to represent a direct analog of the archaeological record as it is recorded through excavation. It is often possible to pinpoint anomalies that correspond to visible archaeological features (Kvamme 2008, Wilson and Schultz 2009), although it is narrow minded to assume that archaeological and archae-geophysical datasets where this is not possible are useless.

It is too early to predict the frequency or relative proportion of North American archaeological sites that will produce clear and interpretable architectural features or other features of interest in present and future geophysical survey investigations or datasets. We do have an understanding of why some sites have a positive feature signal to noise ratio coupled with well preserved archaeological features detectable in geophysical surveys. However, the opposite question is more nebulous: namely, is the absence of geophysical anomalies or features in a geophysical investigation truly the absence of preserved archaeological features? Determining the feature signal to noise ratio of any one site—or more simply put, determining if there is too much noise, be it from modern cultural clutter, background geological and soil conditions, or both—is, and should continue to be, an empirical observation, backed by continued archaeological investigations. Convincing ourselves that we have enough data to start to understand all the factors involved in interpreting the legibility of geophysical data from sites or strata that have not been thoroughly surveyed and investigated archaeologically would be an unfortunate mistake.

Future Recommendations

Archaeo-geophysics, especially as it is practiced in the United States, is still a young discipline with a rapidly evolving set of methods. Large-scale landscape surveys conducted on major sites, such as those presented in Chapters 3-5, are considered by many to be the logical direction the science of archaeo-geophysics is headed (Aspinall et al. 2008:180-188; Becker 2009; Kvamme 2003a; Gaffney and Gater 2003:180-183). Large scale landscape archaeo-geophysical studies have also been practiced with increasing success and frequency by European scholars (Powlesland 2009; Gaffney et al. 2000; Gaffney and Gater 2003:150-155), and along with other notable recent studies in the United States (Kvamme 2008; McKinnon 2008), the datasets discussed in this dissertation are on the leading edge of this type of study. The archaeo-geophysical findings from these projects are not only important with respect to their contributions towards a better archaeological understanding of specific sites in their respective regions, but in a more general sense they are important because they can also be used to aid in future landscape studies at the site or at the regional scale around each of the sites.

In the recommendations that follow on the use of geophysics at various scales in future projects, I first emphasize the recovery of quality archaeological information and survey efficiency. Different survey parameters are also discussed in detail, including using smaller surveys at known sites as an initial assessment of the productivity of various archaeo-geophysical techniques for a given set of geological and archaeological conditions. Next, a broad scale landscape survey strategy is suggested that employs the technique or techniques identified during the initial assessment that have the best likelihood to recover high quality archaeo-geophysical data. The goal of any landscape archaeo-geophysical survey is to highlight the inherent strengths of the geophysical techniques, to rapidly and efficiently cover as large of an area as possible in order to characterize areas of archaeological interest. A third and final stage would be one where the areas of archaeological interest identified in the landscape survey are targeted using a suite of archaeo-geophysical techniques at high sample densities in order to produce high-resolution imagery. These three stages are not meant to necessarily correspond to separate individual stages of a field project, but are meant as a general guide for efficiency and clarity of data collection. Elements of a multi-stage archaeo-geophysical survey design can be incorporated into a single archaeo-geophysical field project, or deployed separately within the context of the different stages of an archaeological investigation (Gaffney and Gater 2003:101).

Based on the findings from the Etowah, George C. Davis, and Hill Farm projects, an integrated archaeo-geophysical survey methodology appears to represent the optimal approach for incorporation of landscape archaeo-geophysics into archaeological research projects. Emphasis should be placed on recording high quality data as well as on ensuing overall survey efficacy. If implemented strategically within of a project's research design and workflow, archaeo-geophysics has the potential to both greatly increase the information gained at each stage of the archaeological investigations as well as decrease the time and money necessary to carry to completion archaeological work to identify, evaluate, and intensively study archaeological sites (Lockhart and Green 2006).

Archaeo-geophysics should always be considered as part of the total archaeological tool kit, not as a replacement for actual subsurface investigations (Gaffney 2009:204). Several datasets do indeed exist where detailed archaeological interpretations were based on geophysical data alone (Kvamme 2008; Kvamme and Ahler 2007, Perttula et al 2008). Many more datasets exist, however, that are more ephemeral with respect to their archaeological character, more noisy, and more difficult to interpret simply from an archaeo-geophysical perspective (Walker and Perttula 2007a, 2007b; Walker 2007b). These more ephemeral, and really more typical data sets require the combination of traditional archaeological data (such as distributions and densities of artifacts, features, and architectural features) with geophysical data in order to isolate culturally significant patterns and trends within a particular site or across a landscape. This fact also cautions against the notion that geophysics can be used alone, or solely relied upon, as an expedient means to survey an area to identify archaeological sites or complete an evaluation of an archaeological site in a proposed development area.

There is a common misperception that geophysics "does not work" in some areas; this is simply not true. Such misplaced thinking is typically offered as an ad hoc explanation for negative results, when understanding the parameters of the local geological and archaeological record is more critical in formulating archaeo-geophysical explanations of the geophysical datasets. Archaeo-geophysics, however, is not always a turnkey solution for detailed landscape analysis. Like all archaeological methods and techniques, archaeo-geophysical investigations on both site and landscape scales will take patience and rigor to perfect, and such investigations will have to be attended to on a region-by-region basis before it becomes evident in what situations and in what contexts archaeologically useful geophysical data will be obtained. It is through the continued incorporation of archaeo-geophysical investigations in regional archaeological research efforts that these methods and techniques will become more useful to the archaeological community as a whole.

It is important that future joint geophysical and archaeological investigations give relatively close attention to areas of potential archaeological significance marked by subtly defined geophysical anomalies, not just those areas that may have clear and legible geophysical signatures of features and structures. Caution should always be exercised when excavating in such areas defined by geophysical survey, being mindful of the possibility that any magnetic anomalies may be represented by subtle soil color and/or texture variations that may be otherwise easily overlooked. Similarly, the anomalies detected may be sufficiently subtle that the temptation may arise (in the absence of other data) to conclude that no anomalies of archaeological significance actually exist in an area of archaeological study. Such hasty conclusions should be resisted without first taking a comprehensive view of the structure and character of a site's archaeological record from subsurface explorations (i.e., at a minimum, intensive shovel testing and exploratory backhoe trenching/scraping) in the same study areas. Many have cautioned against using archaeo-geophysics to prove the absence of data (Linford and David 2001:87, Walker and Perttula 2008; Gaffney 2009:202).

To build on geophysical findings some form of excavation program is absolutely essential to better ascertain the archaeological context and cultural associations of the various anomalies identified in the work. Depending upon the scale of the archaeo-geophysical survey effort, archaeological excavations could consist of a program of systematic shovel testing across the larger geophysical anomalies as well as controlled hand-excavated units in key locales within geophysical collection grids or GPS-derived locations to obtain information on the character of the archaeological deposits in these areas. Such archaeological investigations, if carefully done and specifically targeted to these locations to minimize damage to a site's archaeological deposits, are certainly necessary to further advance and develop interpretations of the cultural significance of any detected geophysical features and anomalies.

ARCHAEO-GEOPHYSICAL ASSESSMENTS TO LANDSCAPE SURVEYS

The assemblage of variables impacting the results of archaeo-geophysical research is staggering. Ballpark predictions of archaeo-geophysical data quality can be made before one enters the field since they can be based on information provided by previous archaeological work in a given region; the nature of the geology and geomorphological setting of the area; the current land cover and land use; as well as the general impacts present in the modern cultural landscape (Clark 1990:158-164; Gaffney and Gater 2003:77-101; Waters

2009:189-191). However, actual fieldwork is required to discern the level of utility that archaeo-geophysical investigations can offer in a given archaeological region that has a particular range of near-surface sites, buried sites, and distinctive site characteristics. With this in mind, archaeologists would greatly benefit from incorporating archaeo-geophysical investigations at different levels of intensity and spatial scales in research designs at different phases of investigation.

Archaeo-geophysical assessments as proposed here consist of a field test of various geophysical methods and techniques to accurately gauge the degree of clarity of their results. This type of geophysical survey can be used as a part of site evaluative testing, in the beginning stages of a data recovery project, or simply to assess the potential use of archaeo-geophysics for a given region as part of a broad-scale archaeological survey or the development of a landscape study. The primary goal of an archaeo-geophysical assessment, then, is to document the nature and quality of archaeo-geophysical data for a given area, and how best to collect such data. Used together with site evaluative testing, an archaeo-geophysical assessment can be employed to determine the potential for incorporating geophysics at an increased spatial scale for later phases of research or to help identify specific key characteristics of a site (i.e. the use of GPR to measure the depth to bedrock, or stratigraphic work to supplement geomorphological test trenches).

When possible, landscape surveys should be preceded by archaeo-geophysical assessments so that geophysical information on both the target archaeological features as well as their geophysical signatures is known or can be readily established for future interpretive efforts. Landscape surveys can and should be implemented on a much larger scale than any archaeological excavations that may be planned within the geophysical survey area, as the speed and spatial scope at which archaeo-geophysical surveys can be conducted allows archaeologists to greatly widen their view of the character of the archaeological landscape. Thus, they can employ geophysics as an integral tool that adds to their understanding of the entire prehistoric landscape in which the sites they are studying are located.

HIGH RESOLUTION MULTI-SENSOR SURVEYS

High resolution multi-sensor surveys can and should be conducted first in situations where the specific nature of the archaeological target is known with some precision (i.e., following up a successful landscape survey) but due to political or economic reasons actual excavation are by necessity either limited in scope or not possible at all. In this situation, multiple techniques can be used in tight collection intervals. Extra precautions can also be taken during such archaeo-geophysical investigations, such as collecting data in a single direction, to provide the greatest possible data quality. These surveys are time consuming when compared to the other previously mentioned types of archaeo-geophysical survey, but nevertheless will still progress much faster, and cover a larger archaeological area, than actual manual excavations can.

Multi-sensor surveys are also useful to combine with landscape surveys. Landscape surveys will typically rely on one or more geophysical method that is rapidly operated, such as magnetometry, conductivity, or magnetic susceptibility, the goal being to simply locate archaeological features or areas of archaeological interest on the landscape. Once this is accomplished, a high-resolution multi-sensor survey can be conducted to obtain more specific information from the cultural features or anomalies that have been identified. This is accomplished by both increasing the sample density as well as the spatial control of the survey. For instance, magnetometer data could be collected at 25 cm traverse intervals using a uni-directional survey pattern; this would greatly increase the detail in the data but would also increase the time of the survey. Slower geophysical techniques such as GPR and resistivity could also then be used to further refine the clarity of the archaeological targets and the amount of archaeological information that can be obtained from the survey.

The strategic employment of archaeo-geophysics into multiple stages of the archaeological process can ultimately decrease the amount of time required to conduct archaeological site assessments, evaluative testing, and data recovery excavations, whether as part of a single project or as embedded in a larger landscape study. It is imperative that the archaeo-geophysical and archaeological data are effectively integrated and that there is mutual feedback between project principals during the course of a project concerning the results obtained by one set of methods or both. Archaeo-geophysical surveys can allow archaeologists to investigate a much broader area of a site or a landscape and help to more strategically locate the areas they choose to manually excavate within either or both areas. Archaeo-geophysics has the clear potential to provide more useful archaeological information if it is threaded into the workflow, and used at varying levels of intensity, throughout the various phases of an archaeological investigation.

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